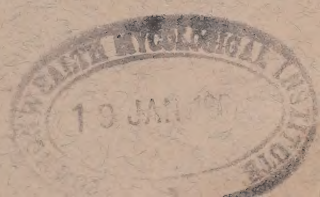
INDIAN TEA ASSOCIATION

SCIENTIFIC DEPARTMENT

TOCKLAI EXPERIMENTAL STATION

ANNUAL REPORT—1954



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Director's Report

Staff.—The following Senior Officers took overseas leave during the year : Director, Dr. Wight, Mr. McTear, Mr. Glover, Mr. S. K. Dutta and Mr. A. D. Swan.

Mr. E. D. Heath, B. Sc., who had been in training in the Agricultural Branch at Tocklai, proceeded to Cachar to take up his duties as Advisory Officer, Cachar, on December 13th.

Mr. J. H. Blair joined the Station as P. A. to the Director on the 1st December.

The Senior Staff at 1.1.1955 was as follows :—

R. J. McILROY	...	Director
W. WIGHT	...	Senior Botanist
N. G. GOKHALE	...	Senior Physical Chemist (Soils)
D. J. WOOD	...	Senior Biochemist
S. K. DUTTA	...	Senior Agriculturist
G. M. DAS	...	Senior Entomologist
I. McTEAR	...	Resident Engineer
K. C. SARMAH	...	Mycologist
J. M. TRINICK	...	Tea Taster
M. J. GREEN	...	Botanist
N. B. CHANDA	...	Biochemist
D. N. BARUA	...	Plant Physiologist
D. N. BORBORA	...	Maintenance Engineer

Advisory Service.

P. M. GLOVER	...	Senior Advisory Officer, Assam
R. I. MACALPINE	...	Senior Advisory Officer, West Bengal.
A. D. SWAN	...	Advisory Officer, Darjeeling
E. D. HEATH	...	Advisory Officer. Cachar

Appointment to the post of Assistant Agriculturist is pending.

Buildings.—Earthquake damage in the Guest House and several bungalows has been repaired. The flat roofs of the Guest House and bungalows 4 and 5 which have been continually under repair are in process of replacement by pent-roofs of asbestos sheet. Bungalow No. 2 which was in dilapidated condition has been demolished and is being replaced by a plinth bungalow on the same site. A bungalow for the Assistant Agriculturist is under construction at Borbhetta.

The factory for prototype machinery at Tocklai has been completed and now houses the withering tunnel, prototype rolling machinery, and the pneumatic drier.

Lecture Courses.—Four short lecture courses were held between February 22nd and March 6th and were attended by 80 planters. Two short courses on Vegetative Propagation were held from the 26th April to 1st May inclusive. 25 planters attended.

Conference.—The Annual Conference held at Tocklai from December 6th to 8th took the form of a symposium. The topics discussed were (1) Withering, (2) Shade and (3) Drainage and Soil conservation. The topics were introduced briefly by specialist officers. Discussion was vigorous and it is believed that the new style of Conference was a success.

Scientific Department Sub-Committee.—Two meetings of this Committee were held at Tocklai during the year, on May 24th and December 9th.

Other Meetings.—Tocklai was represented at the following meetings :

20th January	...	Annual General Meeting, Terai Planters' Association—Mr. Macalpine and Mr. Swan.
21st January	...	Annual General Meeting, Dooars Branch Indian Tea Association at Telepara, Dooars —Director.
3rd February	...	Annual General Meeting, Surma Valley Branch Indian Tea Association, Cachar—Mr. Gokhale.
10th February	...	Assam Branch Indian Tea Association at Jorhat—Director.
12th February	...	Annual General Meeting, Assam Branch of British Medical Association at Tocklai—Director.
6th March	...	Annual General Meeting, Darjeeling Branch Indian Tea Association at Darjeeling—Mr. Macalpine, Mr. Dutta and Mr. Swan,
11th March	...	Scientific Department Sub-Committee, Calcutta—Director.
12th March	...	Annual General Meeting, Indian Tea Association, Calcutta—Director.
20th March	...	United Planters' Association of Southern—India—2nd Annual Scientific Conference at Coonoor—Director.
10th April	...	Indian Tea Planters' Association meeting at Jalpaiguri—Mr. Macalpine.
15th October	...	Scientific Department Sub-Committee, Calcutta—Director.
19th and 20th November	...	Annual General Meeting, Assam Branch Indian Tea Association at Jorhat—Director and Mr. Glover.

29th November ... Ad Hoc Research Committee, Tea Board, at Calcutta—Director.

The Ad Hoc Research Committee of the Tea Board visited Tocklai on January 11th and the Plantation Inquiry Commission visited Tocklai on 1st and 2nd November.

Publications.—The following Tea Encyclopaedia serials were issued :

62/1—Blister Blight with an appendix on spraying technique K. C. Sarma & P. M. Glover.

63/1—Brown Blight and Grey Blight—K. C. Sarma.

101—"Damping off" disease of young Tea seedlings—K. C. Sarma.

33/2—Recipes for pesticides which can be prepared on the Gardens—P. M. Glover (revised).

82/1—Notes on Bamboos—R. I. Macalpine & P. M. Glover (revised).

102—Miniature Manufacture of leaf from single bushes—D. J. Wood and I. McTear,

75/2—Index of Tea Encyclopaedia Serials to end of June, 1954.

105—Replanting of Tea—S. K. Dutta and E. D. Heath.

"The morphological basis of quality in tea"—W. Wight and P. K. Barua—Nature—1954, **173,** 630.

"Calcium oxalate crystals as an indicator of nutrient balance in the tea plant"—W. Wight and D. N. Baruah, Current Science (India) 1954, **23**, 78-79

Tocklai News Letter, Vol. 1 Nos. 1, 2, 3 and 4.

"Mechanisation in the Tea Industry in Northern India"—R. J. McIlroy and P. M. Glover—World Crops, Vol. **6,** No. 5, 1954.

"Natural factors and their influences on Tea production"— by N. G. Gokhale—World Crops, Vol. 6, No. 7, 1954.

"Theanine, an amino-acid N-ethyl amide present in tea"— by R. A. Cartwright, E. A. Roberts, and D. J. Wood. J. Science of Food & Agric. 1954, **5**, 597.

Work of the Station :

Manufacture :

It has been found that caffeine stimulates oxidation of catechins and is thus concerned in fermentation of the leaf. An investigation of the maturing of teas has given extremely interesting results. It has been shown that fired teas still possess appreciable enzyme activity and that, provided sufficient moisture is present, fermentation can continue after firing. The enzyme in fermented leaf is much less sensitive to heat than the enzyme in fresh leaf. This post-firing fermentation is considered to be partly if not largely responsible for the maturing of teas and also for their ultimate deterioration on prolonged storage.

Withering.—Further trials have been carried out in the experimental withering chamber in order to determine the best set of physical conditions for use in a commercial withering tunnel. Comparisons of teas made from leaf withered naturally at the usual thickness of spread and tea made from leaf stored overnight and then withered in 3 hrs. at a spread of 3½ lbs. per square yard showed no significant difference in leaf appearance and liquors. Leaf artificially withered at a spread of 1 lb. per square yard showed no improvement over leaf artificially withered at a spread of 3½ lbs. per square yard. A comparison of natural wither and an artificial wither at 100° showed no significant difference. It is concluded that tunnel withering has no adverse effect on plains teas.

A prototype withering tunnel based upon the results of trials conducted in the experimental withering chamber is nearing completion and will be ready for trial in the 1955 plucking season. The tunnel may be used for alternating air-flow with stationary leaf trays or for progressive movement of the trays according to choice. Each unit may be a combination of 2, 3 or 4, fan units according to Estate requirements when the charge of

fresh leaf per unit will be 4140 lbs. 6210 lbs., and 8280 lbs. respectively and the time necessary to evaporate 35% of the leaf moisture will be 4 hours.

Rolling.—The prototype continuous roller has been given further trials as a result of which the screw has been modified. In comparison with teas rolled and manufactured according to normal factory procedure, the teas produced by the continuous roller were preferred by the tea taster. They were not, however, equal to C. T. C. teas. A larger scale continuous roller is new being fabricated in Calcutta and should be ready for trials in the coming season.

A cross-section roller sent to Tocklai for test has proved to be disappointing. This machine imparted a twist to the teaf but did not achieve the leaf damage necessary for fermentation.

Firing.—A pneumatic ring-drier supplied by a commercial firm has been given preliminary trials. Modifications will have to be effected in the "leakage" louvres to ensure adequate recirculation, but the major defect of the machine is the undesirable appearance (greying) given to the tea.

It is hoped that a "drum drier" may be made available for testing in the near future.

Mechanisation.—As a result of trials carried out with a mechanical tea harvester sent to Tocklai from London, modifications are being effected in the pitch of the cutter blades and the speed of the machine. The harvester shows more promise than any model tested previously.

A tractor propelled spraying implement has been designed by the Advisory Officer. Assam and is being put into production by a commercial firm. It is believed that this implement will prove useful on well roaded gardens and for anti-malarial spraying of line houses etc.

Tea Culture.—The conclusion reached in the 1953 report that yield is significantly increased under reduced light intensity has been confirmed. Under 70% of full light the yield was increased by 29% and under 50% light by 19%.

Experiments on the time of planting seed at stake indicated that the best time is late September to November.

Comparisons of different systems of planting seedlings showed that in general bheti planting is preferable. Manurial trials with tea seedlings indicate that 1 : 2 : 3 N. P. K. mixture at 2 lbs. per acre at fortnightly intervals for a period of 6 months is beneficial.

Comparative trials are in progress with alternative green crop species e.g. Indigofera, Cassia, Desmodium, Priotropis, other species of Crotalaria, and some legumes.

In the experiments on reduced light intensity under bamboo screens it was found that shade increased the weight of the shoots and evidence has been presented which indicates that shade increases the number of pluckable shoots.

Six manurial trials using further levels of N.P.K. have been laid out on tea estates during this year.

Analysis of the results of an experiment on the manuring of a bi-clonal seed bari has shown that seeds from trees receiving heavy doses of superphosphate have low viability. The germintion of seeds is reduced by one third when the dose of phosphate is increased from nil to 300 lbs. P_2O_5 per acre. Increasing doses of phosphate have not shown any effect on the set of the seeds.

It has been found that yield is maximum when annual pruning is carried out in November—December (the period of maximum growth) and minimum when carried out in July. From a knowledge of the yield during any period of the year, for a particular month of pruning, it has been found possible to estimate the yield one can expect to obtain during any period of the year for any month of pruning.

The effect of varying light intensity on the growth and assimilation of different phenotypes of tea is being studied. Two clones representing extremes and two clones from intermediate

positions on the phenotype scale were vegetatively propagated in September 1953 and subjected to varied light intensities by means of bamboo screens from May 1954.

Tea Aroma.—A method has been developed for determining the total volatile matter of a tea. This consists of steam distilling a certain weight of tea under standard conditions and recording the amount of permaganate required to oxidise the volatile matter in the distillate. The method should prove of value for comparative purposes. By comparing teas made from the same leaf, but manufactured under different conditions, it will be possible to obtain information on the conservation of flavour during manufacture.

Soils—The effect on the soil exchange complex of continuous leaching with sulphate of ammonia on soils has been examined and it has been shown that this treatment brings about rapid diminution in the exchangeable metal cations and especially the exchangeable calcium. The contribution made by the organic matter fraction to the total exchange capacity of soils has been measured by determining the total exchange capacity of a number of soil samples by leaching with ammonium acetate before or after destruction of organic matter with hydrogen peroxide. The percentage of exchange capacity contributed by the organic matter varies with the type of soil and ranges from about 30% to 90% of the total exchange capacity.

Pot culture experiments are in progress to determine deficiency symptoms of (a) nitrogen, (b) phosphorus, and (c) potash.

Plant Pathology—In control of eelworm in nursery sites, Shell D-D fumigant has shown a reduction in eelworm population and the plants were larger and heavier. Methyl bromide also reduces the infestation, but appears to retard the growth of the plants to some extent.

Aramite has continued to give promising results in the control of red spider. Aramite does not taint the made tea.

AGRICULTURAL BRANCH

Senior Agriculturist—S. K. Dutta, B.Sc. (Bom.), B.Sc. (Wales).

1. Staff.—Mr. E. D. Heath was in training with the Senior Agriculturist.

Mr. S. K. Dutta was on U. K. leave from 23/6/54 to 30/11/54. During this period Mr. E. D. Heath was Acting Agriculturist. Mr. E. D. Heath then left for Cachar on 14/12/54.

2. Labour.—The average daily attendance during the year was :—

Tocklai	...	22
Borbhetta	...	343.24

Rice Allowance was discontinued and wages were increased as from the 1st June 1954.

3. Crop Yield.—The total yield of green leaf during the year compared with that of 1953, was as follows :—

1953	...	1,93,073½ lbs.
1954	...	2.33,542¼ lbs.

Of the 1954 yields, 2,11,192 lbs. were sold to Messrs. Jorehaut Tea Co., Ltd., at Rs. 20/- per maund.

General plucking was stopped on the 15.11.54.

4. Advisory.—262 letters were written by the Branch in answer to queries on technical matters.

5. Tours.—The Senior Agriculturist and the Acting Agriculturist visited 38 gardens in the Dooars, Cachar and Assam during the year.

6. Publication and Lectures.—Tea Encyclopaediea Serial No. 105 was published jointly by the Agriculturist and Mr. E. D. Heath.

The Agriculturist gave 4 lectures on Plucking during the Annual Lecture Courses and a series of lectures on Vegetative Propagation during two special courses in April/May 1954.

7. Buildings.—A new Leaf Storage House was built at Borbhetta.

8. Experiment B. 29 5—To Study the Application of Phosphate to young Tea at the time of planting.

This experiment was conducted during 1950/52, using plants of an Assam type of clone.

The layout was a 5 x 5 Latin Square with split plots, these being split for "depth of holes" dug to receive the transplants. Depths chosen were 12" and 24". Five phosphate treatments were then laid out in five replicates on a latin square design. Treatments were nil, $\frac{1}{4}$ oz, $\frac{1}{2}$ oz, 1 oz. and 2 oz. of superphosphate per plant (approximately = 0, 10, 20, 40 and 80 lbs. per acre of P_2O_5). The method of application was to dig the holes to requisite depth, fork the soil loose at the bottom, and place the phosphate on top of the loose soil immediately prior to planting. Each main treatment involved 6 clonal plants, and the whole experiment involved 150 plants.

Planting was at 3' square, and done on 27/29-4-50 with 18 month old plants, the height of each being measured. The plants were uprooted on 28-10-52, i.e. at $2\frac{1}{2}$ years old, and height and weight measurements were taken.

Results :—

Data used to judge the effect of the treatments were :—

(1) Increase in height of the plants (final height minus initial height).

(2) Total weight of plants when uprooted at the end of the experiment.

(3) Number of deaths which occurred.

This data is summarised in tabular form below :—

TABLE I

Increase in height of plants (Phosphate treatment)

Nil	10 lb.	20 lb.	40 lb.	80 lb.	
9′ 2½″	3′ 7½″	2′ 7½″	6′ 9″	3′2½″*	
2′ 1½″	15′ 5″	7′ 10½″	14′ 2½″	15′6″	
13′ 9″	16′ 9″	6′ 1″	4′0″	10′3″	Each figure is total for the plot.
3′ 10″	8′ 0½″	18′ 10″	2′ 10″	14′3½″	
6′ 11″	10′ 3½″	15′ 7½″	9′ 11″	13′11″	
Total—35′ 10″	54′ 1½″	51′ 0½″	37′ 9½″	50′9″	
Mean incr. in ht. in 16·5″ inches	25·0″	23·6″	19·0″	24·3″	

*Owing to mortalities in this plot, the total weight of plants after 2½ years was less than the initial weight.

TABLE II

Final weight of plants—(Phosphate treatment).

Nil		10 lb.		20. lb.		40 lb.		80 lb.	
lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.
16	5	19	14	9	0	6	12	3	7
5	13	13	5	9	13	18	1	15	15
17	3	10	6	10	2	11	3	8	8
6	14	8	6	19	4	9	0	13	10
8	6	9	8	13	12	14	4	17	1
54	9	61	7	61	15	59	4	58	9
33·6		37·8		38·1		39·5		37·6	

Total—
Mean wt. per plant in oz.

TABLE III

Final weights (Depth of planting).

	A (12")		B (24")	
	29 lb.	11 oz.	60 lb.	14 oz.
	31 lb.	8 oz.	21 lb.	7 oz.
	19 lb.	13 oz.	35 lb.	4 oz.
	17 lb.	6 oz.	26 lb.	14 oz.
	24 lb.	4 oz.	28 lb.	11 oz.
Total—	122 lb.	10 oz.	173 lb.	2 oz.
Mean wt. in oz.	32·2 oz.		42·1 oz.	

TABLE IV

Final weight (depth × phosphate)

Phosph. Depth	NIL		10 lb.		20 lb.		40 lb.		80 lb.		Total		X in oz
	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	
A (12")	25	11	24	10	29	4	16	5	26	12	122	10	32.2
B (24")	28	14	36	13	32	11	42	15	31	13	173	2	42.1

The death rate observed after 2½ years was as follows :—

Phosphate treatments :—Number of plants initially in each treatment was 30. Number of deaths in each treatment was—

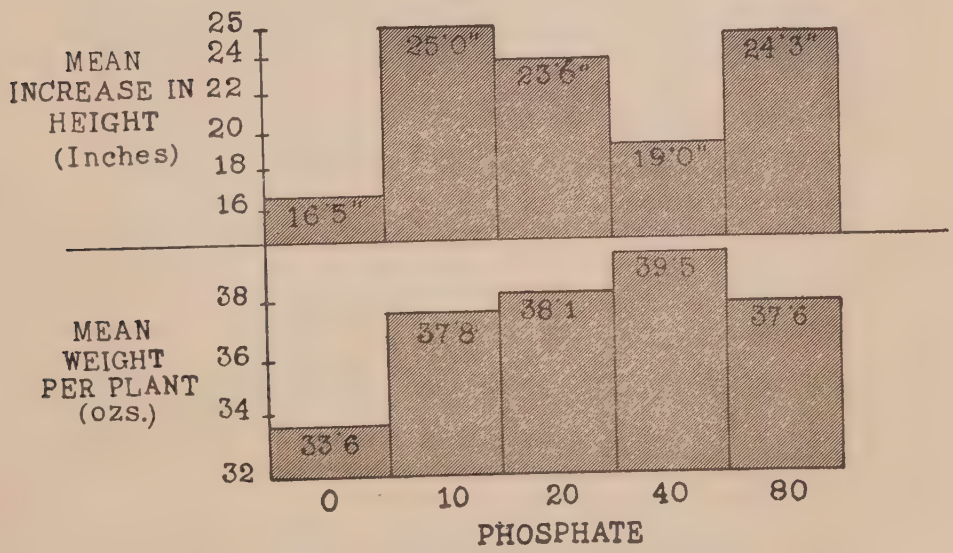
No phosphate	...	4 deaths
10 lb.	...	4 ,,
20 lb.	...	4 ,,
40 lb.	...	6 ,,
80 lb.	...	5 ,,

Depth of planting :— Number of plants initially in each treatment was 75. Number of deaths in each treatment was—

A (12")	...	14 deaths
B (24")	...	9 ,,

The greatest differences in this experiment are to be seen between the two depths of planting. Tables III and IV give the figures which illustrate this. It is seen that there is a 30% increase in the weight of plants from the 24" planting compared to the 12" planting, and if we look at the mortality figures, it is seen that part of this increase is due to the very much higher death-rate amongst the plants from 12" planting, where almost 10% of the plants died. This serves to emphasize the necessity of loosening the soil to a considerable depth to ensure good results.

As regards the phosphate treatments, in all cases where phosphate was applied at the time of transplanting, the plants made better growth, being taller and heavier after 2½ years. Effects can be more easily seen at a glance in the graph below :—



It is quite obvious that the application of phosphate is beneficial ; it is also obvious that the mere application of only 10 lb. per acre of P_2O_5, or ¼ oz. per plant of superphosphate, is virtually just as good as the higher rates of application. There is no difference whatsoever in the mortality rate under phosphate vs. no phosphate treatments at this level of application.

Conclusion :—

1. The results indicate that, when transplanting, holes should always be dug to a depth of at least 24". (Digging to 18" and loosening the soil down to 24" may be regarded as amounting to the same thing.

2. The application of as little as ½ oz. of superphosphate per plant at the time of transplanting appears to have a beneficial affect on the subsequent growth of plants, these being taller and weighing heavier after 2½ years.

9. Expt. B. 50.—***Experiment to study the effect of different feeding treatments on nursery seedlings.***—The object of this experiment was to find a suitable standardised manure mixture which could be applied, safely and beneficially, to young tea seedlings in the nursery.

In the last week of December 1952, some commercial seed of an Assam jat was sown, and the treatments were commenced in August 1953.

Treatments, numbering five, were as follows :—

1.	Liquid cattle manure	...	1 pint to ½ gallon water.
2.	N. P. K.—3:1:1	...	N_3 = 2 lb. N per acre.
3.	N. P. K.—1:2:3	...	N_1 = 2 lb. N per acre.
4.	N. P. K.—3:1:1	...	N_3 = 6 lb. N per acre.
5.	Control	...	No manure.

The nitrogen was in the form of sulphate of ammonia, phosphate as superphosphate and potash as sulphate of potash. The liquid cattle manure was prepared as per the Tocklai Standard Recommendation (Tea Encyclopaedia, Serial No. 58, file under D. 5).

For convenience of application, each inorganic mixture was added to a suitable volume of sand, thoroughly mixed, and the plots were watered after each application. Each treatment was replicated four times.

To form a Guard Line between plots in the nursery bed, and to ensure the isolation of treatments, asbestos sheets were placed in the soil to a depth of 9", and covering the whole width of the bed, between each plot.

Initially, the same number of seeds was planted in each plot, but the treatments were only applied to those which germinated. There is thus a variation in the number of experimental plants per plot, which is adjusted in the calculations. (This variation ranged from 14 to 25 plants per plot, the actual mean being 19.5).

The treatments were applied 12 times between August 1953, (i.e. at 8 months after planting seed) and February 1954, at fortnightly intervals. Then from 23rd to 25th June 1954, (i.e. at 18 months of age) observations were taken on the height of each plant, using a steel rule, and on the diameter at the collar of each plant, using a micrometer. The results of these observations are presented in tabular form below.

Mean Height of Plants in Inches.

Treatment / Block	T_1	T_2	T_3	T_4	T_5	Total
B_I	23.99	27.67	26.44	28.65	16.36	123.11
B_{II}	24.32	22.14	25.11	25.22	24.14	120.93
B_{III}	24.59	26.95	34.12	27.25	21.32	134.23
B_{IV}	22.91	34.28	36.87	24.68	25.38	144.12
Total	95.81	111.04	122.54	105.80	87.20	501.07
Mean	23.95	27.76	30.64	26.45	21.80	25.05

Significant Difference between total = 22.83 (P = 0.05)

Mean Diameter at collar in inches

Treatment / Block	T_1	T_2	T_3	T_4	T_5	Total
B_I	.357	.381	.364	.382	.281	1.765
B_{II}	.322	.330	.357	.348	.326	1.683
B_{III}	.352	.385	.449	.388	.332	1.906
B_{IV}	.350	.436	.471	.409	.388	2.054
Total	1.381	1.532	1.641	1.527	1.327	7.408
Mean	0.345	0.383	0.410	0.382	0.332	0.370

Significant Difference between total = .162

The increase in the mean height of plants under treatment 3 compared with the control, i.e. Treatment 5, is seen to be 8.84", an increase of 40%. Likewise there is a 23.5% increase in the mean diameter, comparing the same treatments. Cattle manure i. e. Treatment 1, whilst producing a slight increase in height and diameter, is probably not an economic proposition.

Conclusions.—Of the treatments tried in this experiment, it would appear that a mixture of N.P.K. in the ratio of 1:2:3 (with N1 – 2 lbs. per acre), applied at fortnightly intervals for a period of 6 months, as described, is beneficial to tea seedlings. In this case, the increase in height over the control of plants under this treatment was of the order of 40% at 18 months of age.

10. Expt. B. 5.—***Observations on Shade Trees.***—Area 5 at Borbhetta is under an NPK and Shade experiment, details of which are as follows :—

November 1932 : Planted with an Assam jat at 4' square.

April 1942 : Planted with Albizzia stipulata shade trees; one tree per 'Shade' plot. (Each plot contains $12 \times 8 = 96$ bushes.)

The manurial treatments are.—

45 lb. P vs. No P
45 lb. K vs. No K
90 lb. N vs. No N
60 lb. N vs. No N
30 lb. N vs. No N

} in all possible combinations with 4 repeats.

On 28th June 1954, three observers from Tocklai took observations on the height and incidence of disease (Canker) of every shade tree in the experiment. The height was measured with an "Auto-Simplex" height measuring instrument, and disease incidence was recorded by the visual score method.

Scoring for disease was on the following basis:—

Healthy tree, entirely free from disease	...		100 marks
Slightly diseased	...	...	60 ,,
Moderately diseased	...	...	40 ,,
Severely diseased	...	...	20 ,,
Dead or infilled	...	...	0 ,,

The scores for each tree were then summated according to treatments, and the figures submited to statistical analysis. Height measurements were similarly analysed.

Analysis of the health-score figures showed the PxK interaction to be significant (P = 0.06). Nothing else was significant. The figures for the P × K interaction are shown in the table below.

	No Phosphate	45 lb. Phosphate	Total
No Potash	760*	1,000*	1,760
45 lb. Potash	880*	700*	1,580
Total	1,640	1,700	

*=Summated score of 16 shade trees.

The only figures showing significant difference are those for Phosphate alone, which is significantly better than P. K. (P = 0·06)

Exactly the same trend was shown on analysis of the height measurements, but these figures failed to show up significantly.

11. Expt. B. 40.—*Effect of P & K with and without Shade*— Area 40 was planted with Tingamira jat in 1922 at 4′6″ triangular. In 1931, an experiment was started to measure the effect of P & K, each at four levels, together with a basic dressing of 40 lbs. N per acre. In 1941, Sau was planted in alternate blocks to study the effect of P & K without shade.

Results of this experiment have been published in detail up to 1948. The results below are for the five year period 1949-53 inclusive.

(*1*) *Shade*— Each year shade has shown a significant increase in yield over no-shade, irrespective of the level or combination of manures (P = 0·01).

(2) *Potash*— This factor reached significance in 1952, when 30 lbs. K and 60 lbs. K both gave significantly higher yields than the check, and 60 lbs. K. gave significantly higher yield than 15 lbs. K (P = 0·05)

(*3*) *Phosphate*—In 1953, the overall effect of Phosphate was highly significant (P = 0·01)

This sporadic significance of P & K (2 and 3 above) can only be assumed to be due to obscure seasonal effects, and there is nothing constant about it. However, this is of minor importance, as one of the main objects of the experiment is to study the effect of P & K together, i. e. their interacting effect, if any.

(*4*) *Phosphate* × *Potash*—It is in this interaction table that the most interesting, and consistent results are to be seen. For example :—

Phosphate × Potash 1949 (mds. per acre made tea).

	P_0	P_{15}	P_{30}	P_{60}	$\bar{X}$
K_0	15·55	16·16	15·24	15·09	15·51
K_{15}	15·67	15·58	16·01	15·74	15·75
K_{30}	15·72	**16·76**	16·58	16·07	16·28
K_{60}	15·50	16·39	16·41	14·48	15·70
$\bar{X}$	15·61	16·22	16·06	15·34	

Significant Difference between individual figures = 1·40 mds.
Significant Difference between $\bar{X}$ = 0·70 mds. (P = 0·05).

This table shows that P_{60} gives significantly *less* crop than P_{30} or P_{15}. Also K_{30} gives significantly more crop than K_0. This highest yielding treatment is $P_{15}K_{30}$, but this is higher than the control (P_0K_0) only when P = 0·07.

Phosphate × Potash—1950 (Yields in mds/acre made tea).

	P_0	P_{15}	P_{30}	P_{60}	$\bar{X}$
K_0	14·76	14·82	14·18	14·03	14·45
K_{15}	14·86	14·80	14·00	15·42	14·77
K_{30}	13·90	**15·96**	15·27	14·95	15·02
K_{60}	15·00	15·22	15·06	14·72	15·00
$\bar{X}$	14·63	15·20	14·62	14·78	

Significant Difference between individual figures = 1·50 mds.
Significant Difference between $\bar{X}$ = 0·75 mds. (P = 0·05).

This table shows similar trends as for 1949, i.e. the higher level of phosphate tends to give less crop than the lower level. The highest yielding treatment is again $P_{15}K_{30}$

Phosphate × Potash—1951 (yields in mds./acre made tea).

	P_0	P_{15}	P_{30}	P_{60}	$\bar{X}$
K_0	10·92	11·28	10·52	10·16	10·72
K_{15}	10·04	11·39	10·38	11·35	10·79
K_{30}	10·70	**11·50**	11·12	11·24	11·14
K_{60}	11·34	11·12	11·38	11·36	11·30
$\bar{X}$	10·75	11·32	10·85	11·03	

Significant Difference between individual figures = 1·19 mds.
Significant Difference between $\bar{X}$ = 0·59 (P = 0·05).

Here, the highest yielding treatment is again $P_{15}K_{30}$.

Phosphate × Potash—1952 (Yields in mds./acre made tea).

	P_0	P_{15}	P_{30}	P_{60}	$\bar{X}$
K_0	13.72	13.82	13.00	12.08	13.34
K_{15}	12.91	14.50	13.27	13.83	13.63
K_{30}	13.56	**14.77**	14.44	14.09	14.22
K_{60}	15.16	14.16	14.84	13.84	14.50
$\bar{X}$	13.84	14.31	13.89	13.64	

Significant Difference between individual levels = 1.64 mds.
" " " $\bar{X}$ = 0.82 mds. P = 0.05)

Still the trend is for the higher level of Phosphate to give less crop than the lower level. K_{30} or K_{60} give significantly more crop than K_0 and K_{15}. Although $P_{15}K_{30}$ was not quite the highest yielding treatment this year, it still gave over 1 md. per acre made tea more than the control.

Phosphate × Potash—1953 (Yields in mds/acre made tea).

	P_0	P_{15}	P_{30}	P_{60}	$\bar{X}$
K_0	12.48	12.35	12.14	10.06	11.76
K_{15}	11.55	12.89	12.12	11.22	11.94
K_{30}	11.74	**12.71**	12.50	10.86	11.95
K_{60}	12.64	12.56	13.18	11.71	12.52
$\bar{X}$	12.10	12.63	12.48	10.96	

Significant Difference between individual figures = 1.57 mds
,, ,, ,, $\bar{X}$ = 0.78 mds. (P = 0.05).

In the table above, P_{60} gives significantly less crop than P_0, P_{15} or P_{30}. The increase due to K_{60} over K_0 is significant. (P = 0.05)

If all the above P x K tables are aggregated, we can obtain a simple picture of the mean effect over the past five years. The result is shown below :—

Mean yields for the 5 year period 1949—1953

	P_0	P_{15}	P_{30}	P_{60}	$\bar{X}$
K_0	13·49	13·69	13·02	12·43	13.16
K_{15}	13·01	13·83	13·16	13·51	13·38
K_{30}	13·12	**14·34**	13·98	13·44	13·72
K_{60}	13·93	13·89	14·17	13·22	13·80
$\bar{X}$	13·39	13·94	13·58	13·15	

It is seen that, over the five years, the mean increase in yield from $P_{45}K_{30}$ compared to the control, P_0K_0, is 0·85 mds. per acre made tea. In actual fact, if the yields for the past 10 years are studied, the mean increase of $P_{45}K_{30}$ over control is 1·1 md. per acre of made tea, because in every year for the past 10 years, this treatment has yielded more than the control. It should be stressed here that the control in this case is **not** "No manures" but 40 lbs, nitrogen per acre.

(5) *Phosphate × Shade*—The interaction between phosphate and shade has consistently shown trends which support those shown by the P × K interaction, viz. that the higher level of phosphate gives less crop than the lower level, under the conditions of this experiment. The interaction table for 1953 is shown below :—

Yield in mds./acre 1953

S P	P_0	P_{15}	P_{30}	P_{60}	$\bar{X}$
—S	9·34	9·92	9·68	8·37	9·33
+S	14·87	15·34	15·29	13·56	14·76
$\bar{X}$	12·10	12·63	12·48	10·96	

Significant Difference between figures within table = 1·11 md.
" " " $\bar{X}$ = 1·85 mds. (P = 0·05).

12. Expt. B. 7.—*Effect of NPK Manuring of Dark and Light Leafed Jats of Tea.*—This experiment was first summarised by Woodford and Cooper in the Empire Journal of Expt. Agriculture, Vol. IX, No. 33 of January 1941. Their summary covered the results upto 1939. Periodic results have since appeared in Quarterly and Annual Reports of the Scientific Department. The present summary relates particularly to the results for the 5 year period 1949—1953 inclusive.

Details of the Experiment.—The tea was planted in 1935, and the experiment started on young tea in 1936. There are 72 plots of a light leafed Assam jat and 72 plots of a dark leafed Assam jat. Each plot consists of 96 bushes.

Treatments were initially as follows :—

N_{20}, N_{60}
P_0, P_{20}, P_{60} } In all combinations.
K_0, K_{20}, K_{60}

Dark leaf and light leaf jat.

(Manures are applied as sulphate of ammonia, superphosphate and sulphate of potash).

Since 1947, however, the nitrogen levels have been N_{40} and N_{120}, all other treatments remaining unchanged. The whole area was planted with shade (Albizzia stipulate) in March 1947.

Results.—Nitrogen—The higher level of N has given significant higher yields than the lower level in every year, i.e. 1949, 1950, 1951, 1952 and 1953 ($P<0.001$).

TABLE I

Jat x Nitrogen

Yields in maunds of made tea per arce

Tea Jat	1949			1950			1951			1952			1953		
N	D	L	$\bar{X}$	D	L	$\bar{X}$	D	L	$\bar{X}$	D	L	$\bar{X}$	D	L	$\bar{X}$
40 lb. of nitrogen	14·80	14·64	14·72	14·54	14·70	14·62	12·02	12·44	12·23	13·85	13·84	13·84	12·74	12·68	12·71
120 lb. of nitrogen	16·93	18·46	17·70	16·48	17·99	17·24	14·10	14·94	14·52	15·02	16.01	15·51	13·84	14·10	13·97
$\bar{X}$	15·86	16·55		15·51	16·35		13·06	13·69		14·43	14·92		13·29	13·39	

D—Dark leaf jat.

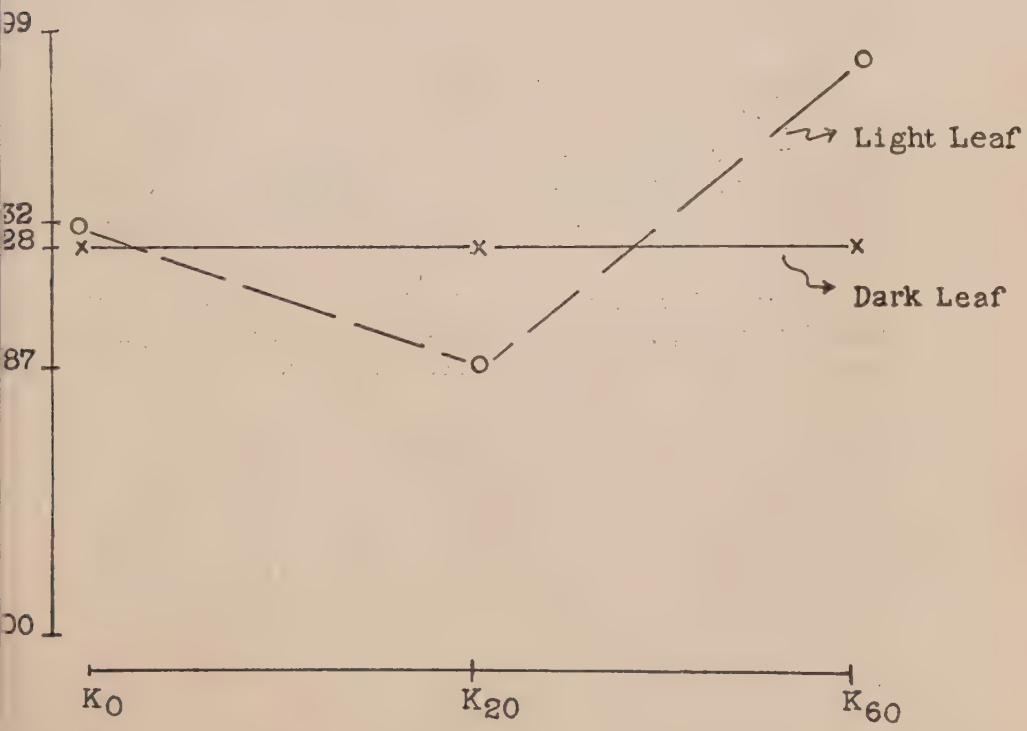
L—Light leaf jat

Jat* × *Nitrogen Interaction.—This had been significant in 1949 at P = 0·01 ; 1952 at P = 0·05. In 1950, it approaches significance (P = 0·07).

The interaction indicates that in 1949, 1950 and 1952, although there was no difference in yield between jats at the low level of nitrogen (N_{40}), at the high level (N_{T20}) the light-leafed jat gave significantly more crop than the dark leafed jat. In other words, the light leafed jat was more responsive to high nitrogen under shade than the dark leafed jat. See Table I.

Jat.—In every year except 1953, there has been a significant difference between jats, the light leafed jat giving more crop than the dark-leafed (1949, 1950 and 1952 when P = 0·05, 1951 when F = 0·01).

Jat* × *Potash Interaction.—This was significant in 1953 (P = 0·01). The trend of this interaction is illustrated by the graph below.



Potash.—Application of potash produced a significant increase in yield over no potash ($P < 0.001$) in 1953, 60 lbs. per acre giving significantly higher yield than either 0 or 20 lbs. per acre.

TABLE II

Yields in mds. made tea per acre

Potash Year	1949	1950	1951	1952	1953	Total
No Potash	16·28	16·27	13·22	14·52	13·30	73·59
20 lb. of Potash	16·08	15·68	13·28	14·56	13·07	72·67
60lbs. of Potash	16·26	15·84	13·62	14·96	13·66	74·34
Total	48·62	47·79	40·12	44·04	40·03	220·60

Phosphate.—The overall effect of application of phosphate in the form of superphosphate at 20 lbs. and 60 lbs. per acre has been significant every year ($P < 0·001$). Both dark and light leaf jats produced a similar increase in yield due to phosphate, the jat × phosphate interaction has never approached significance.

The following table shows the increases of made tea in maunds per acre, due to application of 20 lbs. and 60 lbs. of phosphate per acre with Nil, 20 lbs. and 60 lbs. potash.

TABLE III

Increase due to Phosphate in mds. made tea per acre

	Average 1941-1946	1947	1948	1949	1950	1951	1952	1953	Total	Average
P_1K_0—P_0K_0	0·71	1·10	2·25	1·71	1·67	1·32	0·48	0·96	10·20	1·28
P_1K_1—P_0K_1	0·47	2·00	2·32	2·04	1·92	0·96	0·53	0·95	11·19	1·40
P_1K_2—P_0K_2	1·24	2·94	2·42	2·11	1·80	2·03	1·62	1·41	15·57	1·95
P_2K_0—P_0K_0	1·12	1·77	2·36	2·75	2·95	1·93	1·64	1·20	15·36	1·92
P_2K_1—P_0K_1	0·86	2·20	2·73	2·05	1·83	0·93	1·14	1·98	13·72	1·72
P_2K_2—P_0K_2	1·15	2·23	1·85	1·55	2·31	1·59	1·34	1·22	13·24	1·66

P_0—No phosphate
P_1—20 lbs. of phosphate per acre
P_2—60 lbs. of phosphate per acre

K_0—No potash
K_1—20 lbs. of potash per acre
K_2—60 lbs. of potash per acre

It is interesting to note that an application of 20 lbs. of phosphate per acre has produced in this experiment, an average increase of 1.28 mds. of made tea per acre per year during the 13 years till 1953. It is also interesting to note that the highest increases (1.95 mds.) were obtained from an application of 20 lbs. of phosphate per acre, when the tea had also received 60 lbs. of potash per acre.

Phosphate and Potash interaction :—

TABLE IV.

Increase or decrease in mds. per acre over absolute check (P_0K_0) due to the individual and combined effects of different levels of Phosphate and Potash

Treatments	Average 1941-46	1947	1948	1949	1950	1951	1952	1953	Total	Average
P_1K_0—P_0K_0	0.78	1.10	2.25	1.71	1.67	1.32	0.48	0.96	10.20	1.28
P_2K_0—P_0K_0	1.12	1.77	2.36	2.75	2.59	1.93	1.64	1.20	15.36	1.92
P_0K_1—P_0K_0	0.32	-0.03	-0.48	-0.07	-0.42	0.52	0.18	-0.49	-0.47	-0.06
P_1K_1—P_0K_0	0.79	1.97	1.84	1.97	1.47	1.48	0.71	0.46	10.69	1.34
P_2K_1—P_0K_0	1.18	2.17	2.25	1.98	1.41	1.45	1.32	1.49	13.25	1.66
P_0K_2—P_0K_0	0.10	-0.92	0.17	0.25	-0.38	0.28	0.15	0.20	-0.15	-0.02
P_1K_2—P_0K_0	1.34	2.02	2.59	2.36	1.42	2.31	1.77	1.61	15.42	1.93
P_2K_2—P_0K_0	1.25	1.31	2.02	1.80	1.93	1.87	1.49	1.42	13.09	1.64

P_0—No phosphate. K_0—No potash.
P_1—20 lbs. of phosphate per acre. K_1—20 lbs. of potash/acre.
P_2—60 lbs. ,, ,, ,, ,, K_2—60 lbs. ,, ,, ,,

In the above table, comparisons have been made of the effects of the two levels of phosphate and potash with no phosphate and potash. It is seen that when potash alone is applied, it has a depressing effect on crop. Phosphate alone, even at 20 lbs. per acre, increases yield by 1.28 mds. of made tea per acre. By trebling the level of phosphate to 60 lbs. per acre, we have been able to obtain an extra increase of only (1.92—1.28) 0.64 mds. of made tea per acre.

In this experiment, the highest increases have been obtained with an application of 20 lbs. of phosphate and 60 lbs. of potash per acre, with is somewhat similar to the results obtained in Experiment B.40, described in item No. 11. This increase, however, is in no way significantly more than what is obtained by the application of phosphate alone.

General.—The extra costs of application of these manures with present prices will be approximately as follows :—

20 lbs. of phosphate per acre as superphosphate ... Rs. 22/-

60 lbs. of ,, ,, ,, ,, ,, ... ,, 65/-

20 lbs. of phosphate per acre as superphosphate and 60 lbs. of potash as sulphate of potash ... ,, 52/-

It appears, therefore, that under the conditions of this experiment, it will pay us to apply a manure mixture containing a small amount of phosphate and at least double that amount of potash.

In Experiment B·40, the highest increases have been obtained with an application of 15 lbs. of phosphate and 30 lbs. of potash per acre. This involves an extra expenditure of only about Rs. 32/- per acre.

It must, however, be borne in mind that the results obtained here may not be applicable in all soils.

BOTANICAL BRANCH

YIELD OF THE TEA BUSH

W. Wight, Ph. D., Senior Botanist.

Yield of the tea bush may be expressed in several ways which differ in significance. Each mode of expression provides necessary information and no one mode of expression is complete in itself.

We are greatly indebted to Mr. L. R. Saikiah for his original treatment of the statistics which have led us to the following conceptions.

Net Yield.—This is yield per unit area of real bush surface in the period during which the yield is measured.

Caulome Yield.—This is the yield of an average leading shoot which is 'tipped' to bring the bush 'into plucking' following pruning. Caulome yield can be closely similar to net yield because net yield is much dependent upon horizontal density of caulomes. This is the basis of selection for yield.

The form of the branch system (growth habit) repeats itself when the bush is forced to regenerate. Thus, maidens of fastigiate habit tend towards high yield when they are pruned and plucked, because fastigiate habit leads to a greater horizontal density of caulomes.

Effective Yield.—Other things remaining constant, each jat has a characteristic bush size or area of bush surface. It follows that each jat has a characteristic *space-yield* ; this will be the yield of effective space or area which is required by the average bush of the jat.

All plants start as maidens which occupy an area which does not differ appreciably between jats : subsequent differences become appreciable and cannot be neglected : and relative to these, the initial difference, at the time of plantation, is not of great significance.

Initial spacing of young plants can be decided by the diameter of the 'circle' which a bush will occupy at some future date defined as *coverage date*. If initial spacing be properly adjusted between jats in accordance with their space-yield, then all jats will simultaneously attain coverage.

Technical comparisons are invalid unless all jats do attain coverage simultaneously ; or unless experimental results are adjusted so as to give this picture. Practical comparisons are invalid because it is inefficient to use a common spacing for all jats (unless the spacing be very close, as in hedge planting).

For many field experiments one is obliged to use some constant spacing but the object of jat comparisons is destroyed unless one's conclusions include those based upon the effective ground which will be finally covered by the bush.

One has to specify what is meant by finally covered ; this is the date by which one wishes coverage to be attained, or the desired common coverage date.

The yield *up to* coverage is of practical importance. This is the yield of the space which is required by the bushes and is the yield of their *effective area :* this can be designated *effective yield.*

If the same number of bushes of each jat is planted in a unit area (or acre) of ground for convenience of field trial, then subsequent adjustment to effective area may be required for the trial to have meaning. This can be done by measuring the area of the bushes at the time when coverage is required. The meaning becomes the yield of the ground which is needed by the bushes ; and area which will not be occupied by the desired coverage date is excluded as meaningless. For instance, area not occupied by bushes after fifteen years might be considered meaningless ; or at least, economically wasted. With 4 ft. by 4 ft. spacing some jats do not cover the ground after fifteen years. These jats may not be generally used, but as they are necessary for experimental work their effective area has to be considered.

To sum up, effective yield is the yield per acre of ground when jats have a differential but *equivalent spacing* such that every jat reaches complete ground cover by the end of a common time interval.

After coverage, *net yield* will become of practical importance and approximately the same as effective yield. Net yield is always of theoretical importance.

Bush Yield.—Bush yield is the yield of an individual bush, or the average bush of a jat, supposing this to have sufficient space in which to develop. This is an important physiological concept.

Bush Area.—The surface area of an average bush differs between jats, and within a jat, differs between treatments.

Other things being constant the trend of bush area between jats is in the opposite direction to the trend of net yield.

Effective yield before coverage is depended upon both bush area and net yield and these two factors are not altered in the same way by manures and shade.

Gross Yield.—This is a term for the yield which is obtained from some particular area of ground inclusive of ground not effectively occupied by tea bushes, such as an experimental plot ; or a tea garden section inclusive of open drains (*nullahs*) and pathings.

General Consideration of Yield.—For an appreciable period of time, the gross yield of plots in a field trial (allowance being made for deaths, if any) is tantamount to *bush yield* ; unless initial spacing be sufficiently close for coverage to be attained soon after planting.

If one is to plant closely with the object of attaining early coverage, then it is necessary to know whether manures and/or shade will affect only bush area, or only net yield, or both.

These considerations have a material connection with the genetics of the tea plant and cannot be dissociated from possible improvements of either yield or qualify. They provide information which is essential for the proper evaluation of new material and also for the proper application of information obtained from experiments on existing jats.

TABLE I.

Analysis of variance of BUSH YIELD for 1941.

Variance due to		S. S.	D. F.	Mean Sq.	F.	Probability
Between block pairs	Replicates	342.00	2	1557.31	1.072	...
	N × Jat	7444.56	3			
Within block pairs	SHADE	13205.84	1	13205.84	9.094	*<.05
	N × Jat × S	2387.74	3	1452.19	...	...
Error		4873.22	2			
Sub Blocks		28253.36	11	2568.49	12.941	***<.001
Within block pairs	NITROGEN	47633.06	1	47633.06	239.989	***<.001
	JATS	109975.02	11	9997.73	50.371	***<.001
	N × Shade	4726.57	1	4726.57	23.814	***<.001
	Jat × Shade	2678.24	11	243.48	1.227	...
	N × Jat	6527.75	11	593.43	2.990	**<.01
	N × J × S	2605.53	11	236.87	1.193	...
Error		17069.41	86	198.48	...	...
Total		219468.94	143	...	...	...

TABLE II.

Analysis of variance of GROSS YIELD for 1951.

Variance due to		S. S.	D.F.	Mean Sq.	F.	Probability
Between block pairs	Replicates	35677.347	2	16613.678	1.542	...
	N × J	47391.042	3			
Within block pairs	SHADE	387921.361	1	387921.361	36.010	**<.01
	N × J × S	25742.806	3	10772.561	...	...
Error		28119.999	2			
Within block pairs	Blocks	524852.555	11	47713.869	44.238	***<.001
	NITROGEN	167826.778	1	167826.778	155.599	***<.001
	JATS	27787.889	11	2526.172	2.342	*<.05
	N × S	22052.250	1	22052.250	20.446	***<.001
	JAT × S	8998.639	11	818.058	...	...
	N × JAT	9713.035	11	883.003	...	...
	N × J × S	11727.880	11	1066.171	...	...
Error		92758.196	86	1078.584	...	...
Total		865717.222	143	...	...	...

TABLE III

Analysis of variance of BUSH AREA at the end of 1951

Variance due to		S.S.	D. F.	Mean Sq.	F	Probability
Between block pairs	Replicates	301539·5	2	120147·1	...	...
	N × J	299196·1	3			
Within block pairs	SHADE	5449112·1	1	5449112·1	37·543	**<.01
Within block pairs	N × J × S	180187·2	3	145142·4	...	...
Error		545524·7	2			
SUB BLOCKS		6775559·6	11	61596·0	18·001	***<·001
Within block pairs	NITROGEN	5853173.8	1	5853173·8	171·055	***<·001
	JATS	2993497·8	11	272136·2	7·953	***<·001
	N × S	2076961·4	1	2076961·4	60·698	***<·001
	J × S	263994·5	11	23999·5	...	...
	N × J	209077·3	11	19007·0	...	...
	N × J × S	397878·9	11	36170·8	1·057	...
Error		2942746.5	86	34218·0	...	...
Total		21512889.8	143	...	...	...

TABLE IV

Analysis of variance of total EFFECTIVE YIELD for the years 1941-50 inclusive

Variance due to		S. S.	D. F.	Mean Sq.	F.	Probability
Between block pairs	Replicate	2926·05	2	1708·9	2·018	...
	N × J	5614·40	3			
Within block pairs	SHADE	19810·56	1	19810·56	23·404	**<.01
	N × J × S	1972·90	3			
Error		2259·33	2	846·45	...	...
SUB-BLOCK		32583·24	11	2962·11	28·008	***<·001
Within block pairs	NITROGEN	6547·51	1	6547·51	61·909	***<·001
	JATS	14496·91	11	1317·90	12·367	***<·001
	N × S	45·56	1	45·56	...	...
	J × S	1745·85	11	158·71	1·501	...
	N × J	1278·21	11	116·20	1·099	...
	N × J × S	1619·68	11	147·24	1·392	...
Error		9095·20	86	105·76	...	...
Total		67412·16	143	...	...	...

TABLE V

Analysis of variance of NET YIELD over three years 1949-51.

Variance due to		S.S.	D. F.	Mean Sq.	F	Probability
Between block pairs.	Replicates	2740·875	2	2556·946	1·502	—
	N × J	10043·854	3			
Within block pairs	SHADE	34317·563	1	34317·563	20·155	** < ·01
	N × J × S	3954·298	3	1702·712	—	—
Error		4559·264	2			
SUB-BLOCKS		55615·854	11	5055·987	18·881	*** < ·001
Within block pairs.	NITROGEN	4749·507	1	4749·507	17·736	*** < ·001
	JATS	13109·521	11	1191·775	4·450	*** < ·001
	N × S	25·840	1	25·840	—	—
	J × S	3932·854	11	357·532	1·335	—
	N × J	1604·452	11	145·859	—	—
	N × J × S	3218·007	11	292·546	1·092	—
Errors		23029·403	86	267·784	—	—
Total		105285·438	143	—	—	—

Factors Influencing Yield.—These observations are based upon a field trial designed by Dr. F. Yates of Rothamstead in collaboration with Mr. H. R. Cooper. The trial plots were planted in 1936. Twelve jats were under shade and nitrogen treatments. Each jat was represented by a standard number of bushes in plots of standard size, constant for all treatments. Shade employed was *Albizzia stipulata* spaced 40 ft. x 40 ft.

In the early years, the gross yield of the plots, as recorded by the field staff, may be taken as a reasonable approximation to bush yield. The analysis of variance of gross yield for 1941, considered to be an analysis of *bush yield*, is given in Table I : this shows the nature of the jat to determine significant first order interactions.

Similar significant results were obtained by analysis of the gross yield of subsequent years. Sometimes the interaction of shade with jat attained significance, sometimes it did not do so ; this presumably depending upon seasonally variable factors of canopy foliation and sunlight hours. The important conclusion is that it is possible for the effect of shade to be significantly modified by jat.

Interactions, in terms of gross yield, with the exception of the nitrogen by shade interaction, ceased to be significant in 1949 and remained without significance for three years until the end of 1951 (Table II) after which the nature of the trial was altered. It is supposed that the varietal effect became less as ground coverage increased.

Table III gives the effect of treatment on the bush areas attained by the end of 1951. The effective area covered by the bushes differs between jats : but the nature of the jats has not modified the 'final' (1951) bush size associated with a treatment.

By the end of 1951 it is no longer possible to consider gross plot yield as an approximation to bush yield. The data are therefore transformed to yield of effective area (*effective yield*) on the presumption that jats which had not attained coverage by this date should have done so by the use of the various spacings which are appropriate to the jats.

Table IV gives the analysis of effective yield. This shows that the bush interactions illustrated by Table I lost their significance in the total yield obtained from the area which we suppose to have been necessary up to the year 1950.

The interactions which were observed in terms of bush yield were not reflected in the final *net yield* determined from the shoots plucked over the three years 1949 to 1951 (Table 1).

Conclusion.—The analyses show that the effect of nitrogen on net yield is not modified by shade of the order employed. The interactions which are observed in terms of bush yield seem to be appreciably dependent upon changes in bush area.

EXPERIMENTS ON LIGHT INTENSITY AND PHENOTYPES

D. N. Barua. Ph. D. Plant Physiologist.

The experiment was designed to study the effect of light intensity on the rate of assimilation and the partition of assimilates between the various organs of tea plants in their early stages of growth. Clonal plants were used for the experiment. The four clones selected for this purpose cover almost the entire range of phenotypes now grown in north east India. The four clones are :

Index number of the clone	Remarks.
19/36/15	Glabrous form of the Assam variety.
20/23/1	Pubescent form of the Assam variety.
19/29/13	Heterozygous for characteristics of the China variety and of the southern forms of the Assam variety.
114.	Dwarf form of the China variety.

Internodal cuttings from these four clones were planted in 4′ x 30′ nursery beds (prepared in the usual manner) during September 1953. The cuttings remained under standard lath frame covers until March 1954 when the covers were finally removed and the growing cuttings were exposed to the direct rays of the sun. When the cuttings completed their first flush growth by the middle of May, split-bamboo meshes, supported on bamboo frames, were placed on top of the cutting beds at a height of 2′ 6″ from the ground. To prevent entry of unfiltered light from the sides, the four sides of the nursery beds were covered with bamboo meshes of the same size. The covers at the sides could be lifted whenever necessary.

Three different mesh sizes were used, which, with the check, *i. e.* no shade, provided four different light intensities for the growth of the plants. Light intensity measurements were made with a Weston Photoelectric meter. If the full sunlight on an unshaded bed is taken as 100, then the light intensities under the three different mesh sizes can be expressed as 50%, 35% and

20% of full light. Each light treatment was repeated three times in space, there being altogether 12 beds of four plots, each plot in a bed being planted with cuttings from a different clone. The design of the experiment is illustrated by the following analysis of variance table :

	Block.	2
	Light.	3
Error	(Block × light)	6
	Clone.	3
	Clone × light.	9
Error	{ Clone × block Clone × light × block }	24
	Total	47

Fifty good plants were marked in each plot on the 18th May 1954 and the leaf attached to the original piece of the cutting was cut off from these plants. Bamboo-mesh covers were erected on top of the cuttings on 21-5-54.

Random samples of 5 plants were drawn from each plot from amongst the marked plants at every sampling round. The first sample was drawn on the date of erection of the sheds and the subsequent samples were drawn at fortnightly intervals. All the five plants of a sample were treated as one plant. The sampled plants were cut up into shoots, roots and the original bits of cutting stems. Each part was dried and weighed separately. Before commencement of the experiments, leaf area was shown to be very highly correlated with the product of length and the maximum breadth of the leaf. Hence, for area determination, the length and the breadth of each leaf was measured separately. The regression equations of leaf area on the products of length and breadth of leaves are given in table 1.

TABLE 1.

Clone	Regression equations of area. 'Y' on product 'x'	
19/36/15	$Y = -0{\cdot}95+0{\cdot}6801 \times$ ***	*** Significant at 0·1% level
20/23/1	$Y = 0{\cdot}15+0{\cdot}6499 \times$ ***	
19/29/13	$Y = 0{\cdot}10+0{\cdot}6582 \times$ ***	
114/2	$Y = -0{\cdot}38+0{\cdot}7062 \times$ ***	

Altogether 5 samples were drawn for the computation of Net Assimilation Rates and the partition of assimilates, the last sample being drawn on 14-7-54. One more sample was drawn, two months after the last sample, for observing the general trend of growth of the plants after some of the older leaves were shed.

The plants remaining after the last sample were pruned at the height of the first flush banjhi horizon. The experiment is being continued for observing the effect of light intensity on the rate of production of shoots.

Measurements of air temperature and soil temperature at a depth of 6″, under the four light intensities, were made twice every day throughout the experiment and are being continued. Carbon dioxide concentrations were measured by drawing samples of air in an aspirator bottle and absorbing the CO_2 in a standard solution of baryta, the excess of which was estimated by back titration with standard oxalic acid. The few estimations did not show detectable differences in CO_2 concentration under the different light intensities. Humidity under the bamboo covers will be estimated in further experiments.

Experimental data are being analysed and will be reported fully after completion of the analysis. Results of preliminary statistical analysis on the dry weight of the whole plant are presented in table 2. Data for the five successive samples have been incorporated in the same analysis. 'Sample' in table 2 is, therefore, synonymous with time or the age of plant. The variances due to sample and its first and second order interactions with light intensity and clone have been resolved into their linear and non-linear components. It will be seen from the variance table

that whenever significance is observed, it is always attributable to the linear fraction of the variance. However, in the partitioning of the variance due to sample, the non-linear fraction also becomes significant. But this fraction is negligible compared to the linear part. ($F = \frac{667.17}{7.39} = 90.25, P < .001$).

TABLE 2

Analysis of Variance on the Dry weight of the whole plant.

Sources of variation	Sum of Square	D.F.	Mean Square	F.	
Block ...	158.06	2	79.03		
Light ...	39.46	3	13.15	1.23	
Error ...	63·86	6	10.64		
Clone ...	2329.91	3	776.64	54.12	***
Clone × Light ...	90.66	9	10.07		
Error ...	344.39	24	14.35		
Sample 1 ...	667.17	1	667.17	656.21	***
Sample dev. ...	22.18	3	7.39	7.27	***
Light × Sample 1 ...	12.51	3	4.17	4.10	**
Light × Sample dev. ...	14.11	9	1.57		
Clone × Sample 1 ...	120.19	3	40.06	39.40	***
Clone × Sample dev. ...	9.29	9	1.03		
Light × Clone × Sample 1...	26.73	9	2.97	2.92	**
Light × Clone × Sample dev.	34.31	27	1.27		
Error ...	130.14	128	1.02		
Total ...	4062.95	239			

The suffixes '1' and 'dev' to sample stand for linearity and deviation from linearity respectively.

The major deductions from the analysis in table 2 are as follows :

(1) The average linear rate of increment of dry matter along time of all the four clones is altered by a change in the intensity of incident light.

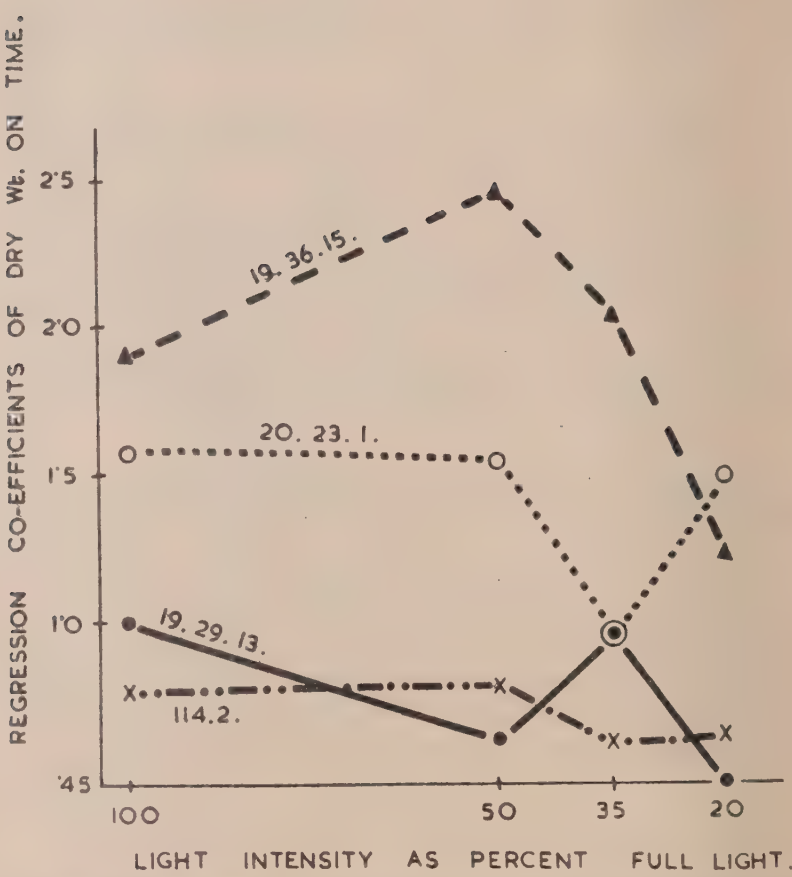
(2) Clones differ in their linear time-rates of production of dry matter when these rates are the average of all the different light intensities.

(3) There is a significant second order interacation of light and clone on the linear rate of increment of dry matter along time.

It is proposed to make use of these significant linear time trends in rectifying the data for calculating Net Assimilation Rates.

Values of the regression co-efficients of dry weight of the whole plant along time for all clones and light intensities are graphically represented in Fig. 1. The rate of growth of clone 19/36/15 appears to be at a maximum at 50% of full light, whereas increase in light intensity above 20% of full light does not appear to have changed the rate of growth of the remaining clones.

FIG. 1.



From previous work at Cambridge with young seedlings, grown under controlled environment, it was possible to suggest that light intensity above 30-35% of the full light at the tropics might not materially increase the capacity for the production of dry matter by young tea plants, grown under natural conditions. Requirement of a higher light intensity for the maximum production of crop by mature, plucked tea bushes, as shown by field experiments, could be due to the mutual shading of the photosynthetically efficient mature leaves remaining below the plucking table. It still remains to be seen whether the light requirement for the optimal production of dry matter by the tea plant differs from that required for the most efficient production of plucked shoots.

BIOCHEMICAL BRANCH.

D. J. Wood, B.Sc. Senior Biochemist.

N. B. Chanda, M.Sc., Ph.D. Biochemist.

Advisory and Publications.—During the year 85 memoranda and advisory letters were written. One Encyclopaedia Serial was issued jointly with the Tea Taster. A paper entitled "Theanine, an amino-acid N-ethyl amide present in tea" by R. A. Cartwright, E. A. H. Roberts and D. J. Wood was published in the Journal of the Science of Food and Agriculture Vol. 5.

Touring.—In May the Senior Biochemist visited the Darjeeling district and carried out withering experiments which are described later on in the report. Visits were also paid to a few gardens in the Jorhat Circle.

FUNDAMENTAL RESEARCH.

The Volatile Constituents of Tea.—Work under this head has continued on the same general lines as those described in the Annual Report for 1953. So far it has not proved possible to identify for certain any of the volatile substances in tea, but certain carbonyl compounds detectable by chromatography appear to have a wide distribution. In addition to aldehydes and alcohols there is evidence of an ester in some teas, notably in two China hybrid clones growing at Tocklai. The acid and alcohol produced by hydrolysis of this ester have both been detected on cromatograms.

A technique which has proved useful for extracting volatile matter from Darjeeling teas is to extract the powdered tea with ether, concentrate the ethereal extract under reduced pressure and then steam distill. This reduces the period of steam distillation and the loss af volatile matter is thereby reduced. Another technique which shows promise is to heat a mixture of powdered tea and water in an autoclave for 30 min. at 1 atmosphere pressure, then partially open the valve and conduct the distillate through a train of condensers into a receiver containing a substituted phenylhydrazine or some other reagent. This method also reduces the loss of volatile matter, and a fair quantity of crystalline hydrazone can be obtained.

Chemical Changes in Withering.—An increase in extractable caffeine during withering, reported last year for the first time, has been confirmed. The increase also occurs when leaf is kept in a saturated atmosphere so that little withering is possible. In one particular clone, examined seven times, the increase averaged 18.2% in 24 hours and 25.4% in 48 hours. These figures are expressed in terms of the dry weight of the original fresh leaf, since loss of solid matter due to respiration during withering or leaf storage can by itself lead to an apparent increase in some of the chemical constituents.

Further evidence has been obtained that an increase in caffeine content of the leaf results in an increase in colour and strength of the made tea. Mixed catechins were oxidised by a crude enzyme preparation in presence and in absence of caffeine. The mixture was then diluted with water, refluxed for 5 minutes to simulate the infusion of tea for tasting purposes, and filtered. The colour intensity of the filtrate with caffeine was considerably greater than of that without. Separation into ethyl acetate and aqueous fractions by shaking once with an equal volume of the solvent showed that the ethyl acetate portion accounted for the majority of the extra colour. The residual leaf tissue from the oxidation in absence of caffeine had more absorbed polyphenol than that in presence of caffeine. The tentative explanation of these results is that when caffeine is present some of the polymers combine with caffeine rather than with protein. The caffeine complex is water-soluble and comes out into a 5 minute infusion, increasing its colour (and strength), whereas the complex with protein is insoluble.

These results may be compared with colorimetric comparisons of teas made from leaf withered for 5 hours, 26 hours and 47 hours respectively to the same moisture content. Total depth of colour increased with duration. When seperated into aqueous and ethyl acetate fractions it was found that the colour of the aqueous fraction increased considerably with duration but that of the ethyl acetate fraction decreased slightly. The caffeine content was least in the 5 hour wither and greatest in the 47 hour wither. There is a general similarity between these two sets of results in spite of the difference when ethyl acetate fractions are taken into account.

One suggestion advanced as a possible explanation for the overall increase in colour of these teas was that the cause might be purely physical. Chemical changes in withering were mainly concerned with breakdown of protein, starch etc. to simpler substances, and this breakdown might lead to increased extractability of soluble products during the 5 minute infusion period. To test this possibility the total soluble solids in 5 minute and 1 hour infusions of the three teas was measured. The average figures (six dates of manufacture) are given below.

	5 min. Infusion	1 hr. Infusion	Ratio 5 min./1 hr.
Withered 5 hours	27·2%	41·7%	0·652
Withered 26 hours	27·2%	41·9%	0·649
Withered 47 hours	27·4%	42·4%	0·646

Increased extractability would be reflected by an increase in the ratio of 5 minute to 1 hour soluble solids. The ratio in fact decreases slightly, so this physical explanation is obviously not the correct one, and the chemical explanation already advanced is more likely.

Maturing of teas.—One of the changes undergone by a tea on storage in akin to a slow continuation of fermentation, and recent investigation of this point has shown that the oxidising enzyme responsible for fermentation is not entirely inactivated when the tea is fired. The enzyme in fermented leaf appears to be much less heat sensitive than it is in green leaf, as if it were protected in some way. Factors leading to an abnormal degree of enzyme activity in a fired tea appear to be short fermentation, low temperature firing and a low air speed in the dryer. The enzyme activity of commercial teas so far tested varies considerably, but is appreciably lower than that of teas fired in the Tocklai dryer. With a tea possessing active enzyme, continuation of fermentation will depend on its moisture content. A totally dry tea cannot ferment, but as it picks up moisture its speed of fermentation will increase. This continuation of fermentation after firing is considered to be partly if not largely responsible for the maturing of teas and also for their ultimate deterioration on prolonged storage.

MANUFACTURE.

Manufacturing Experiments to Test the Principle of Tunnel Withering.—As a result of withering experiments described in the Annual Report for 1953 attention at Tocklai has been directed towards the possibility of tunnel withering on a commercial scale. This type of withering, as envisaged by the Resident Engineer, would involve spreading the leaf fairly thickly (about 3½ lb. per sq. yd.) on very closely spaced trays (2 in. apart) arranged in the form of mobile carriers of some type, and withering in an enclosed tunnel by means of a brisk flow of air heated to give a suitable difference between dry bulb and wet bulb temperature ("or hygrometric difference"). The time taken for the withering operation would naturally depend on the air speed, the hygrometric difference and the degree of wither aimed at, but in round figures would probably be in the neighbourhood of four hours.

With these data to go on together with the results of previous investigations, experiments were designed to test the various aspects of tunnel withering from the point of view of their effect on the manufactured tea. These various aspects are separately discussed below.

Temperature of Withering.—A single bulk of leaf was divided into two portions. One portion was withered naturally at atmospheric temperature in the outside **chung** house, the other was withered in the experimental chamber at 100°F., being maintained at this temperature for approximately 13 hours. Both portions were then manufactured simultaneously under identical conditions, each tea being sorted to give the usual bulk grade. The experiment was performed on seven occasions from the 10th June to the 22nd July, thus covering the late second flush and the early rains period. The following figures show the average degree of wither :

Moisture content of fresh leaf.	% Wither chung house.	% Wither chamber.
75%	69%	66%

On each occasion samples of the two teas were distributed to a panel of Brokers in Calcutta and a similar panel in London as well as to the Tocklai Taster ; their reports were submitted on the

standard tasting form and converted into marks. The table below shows average marks for leaf and liquor characters and average valuations for each of the three Tasters individually and the combined average of all Tasters.

	Tocklai Taster.		Calcutta Panel.		London Panel.	
	Natural wither	100° wither.	Natural wither.	100° wither.	Natural wither.	100° wither.
Infused Leaf	46	40	60	26**	61	44*
Colour	49	43	40	33	49	40
Strength	51	51	63	47	59	43
Quality	47	44	50	47	61	51
Briskness	53	49	56	59	61	50
Valuation	2/3/11	2/3/1	3/2/-	3/1/10	3/3/10	3/3/4

Average of Tasters.

	Natural wither.	100° wither.
Infused Leaf	56	37**
Colour	46	39
Strength	58	47*
Quality	53	47
Briskness	57	53
Valuation	2/13/11	2/13/5

**Difference significant at the 1% level.

*Difference significant at the 5% level.

The natural wither is slightly favoured in all respects, and there is a substantial measure of agreement among Tasters, although the difference between the two teas is only signifiicant in the case of infused leaf and strength. A preference of 6 pies in favour of the natural wither is not significant. It can be concluded that exposure of leaf for 13 hours to a temperature of 100° has probably been to the detriment of the tea, although the effect

is very slight. In a similar, but rather more complicated, experiment discussed in the annual report for 1953 the overall picture was much the same, although withering at 100° actually improved the colour and strength. This was for a period of exposure of 16 hours, and the experiment covered the four months July to October. Since the effect of withering at 100° for 13-16 hours is so slight it is reasonable to suppose that withering at the same temperature for only 4 hours will, in the plains, have an effect which if apparent at all will be easily offset by advantages in other directions.

Rapid Wither after Leaf Storage.

Results obtained in 1953 suggested that, both from the point of view of convenience and in order to ensure good liquoring teas, tunnel withering would best be done after overnight storage of the fresh leaf. During 1954 experiments were conducted to compare this type of withering with natural withering, simulating as closely as possible the conditions which would be met with in commercial operation. Three different types of storage were investigated, described separately below. The stored leaf was given a rapid wither in the air conditioned chamber to the same degree as that withered naturally in the leaf house, the average temperature in the chamber varying from 80° to 96° according to the time of year and the thickness of spread being 3½ lb. per square yard The two lots of leaf were then manufactured simultaneously by identical processes. The experiment covered a wide range of withers, from 55% to 78%, and the style of manutacture (i. e. whether C. T. C. or conventional, and the number of rolls) was suited to the degree of wither obtained. Since it was desired to judge the effect on appearance and style of leaf as well as on liquors the teas were sorted by means of hand sieves into a small number of recognisable grades. Samples of all the grades were reported on by the Tocklai Taster and by Brokers' Panels in London and Calcutta who were asked to value each grade and to make general remarks about the leaf and liquors. From these valuations and the grade percentages an average valuation for each tea was calculated, and these average valuations are tabulated below.

In addition to the three types of storage, the effect of thick spreading during the actual withering operation was investigated, mainly to find out whether this would affect the percent-

age outturn of individual grades and the appearance of the leaf. For this purpose the comparison was between leaf withered rapidly at 12 oz. per square yard and leaf withered rapidly at 3½ lb. per square yard, the leaf being spread on the trays at the requisite thickness in the afternoon and stored in the withering chamber overnight. After withering simultaneously in opposite sides of the chamber, adjusting the air flow to give the same degree of wither in each case, the two portions of leaf were manufactured identically, sorted into grades and distributed to Tasters as before. The results are given below under "Thick versus thin spreading".

(I) Stored in withering chamber.

Leaf was stored overnight on the trays of the withering chamber at a thickness of 3½ lb. per square yard, all doors of the chamber being shut and with the fan and air heater switched off. Without disturbing the leaf the following morning, apart from weighing one tray to obtain the overnight loss, the withering chamber was operated as an open circuit, drawing in outside air, heating it, passing it once through the leaf and ejecting it to atmosphere. The experiment was performed on eight occasions (five times during the second flush, once in the rains, twice in the autumnal period).

	Withered Naturally.	Stored and Withered.
Tocklai Taster	2/2/5	2/1/10
Calcutta Panel	3/4/-	3/3/9
London Panel	4/-/-	4/-/4
Average	3/2/2	3/2/-

None of the above differences in valuation are statistically significant. Tasters' remarks on leaf and liquors show no consistent preference for either tea. On the whole it may be said that the two types of withering have produced teas very similar in all respects.

(2) Stored on hessian trays.

Leaf was stored on the hessian trays used for natural withering, spread at a rate of 15 lb. per square yard (about 4 inches thick), and was left overnight in the *chung* house. The following morning it was transferred to the withering chamber, spreading at 3½ lb. per square yard, and was withered as above in about 3 hours. The experiment was performed six times (twice during the second flush, twice in the rains, twice in the autumnal period).

	Withered Naturally.	Stored and Withered.
Tocklai Taster	2/1/6	2/-/9*
Calcutta Panel	3/5/1	3/5/6
London Panel	4/-/1	4/-/11
Average	3/2/3	3/2/5

The Tocklai Taster shows a difference of 9 pies in favour of the natural wither, this difference being significant at the 5% level. The Calcutta and London panels, on the other hand, give a slight preference in the opposite direction, although these preferences are not significant. The remarks of all three Tasters show that in leaf and liquor these two teas were very similar.

(3) Stored in a basket.

Leaf was stored overnight in a large plucking basket, the depth of leaf being 10—12 inches. Except on one occasion at the end of November, when temperatures were low, a certain amount of leaf reddening occurred in the basket, affecting perhaps 10% of the leaf. A slight sourish smell was sometimes noticeable in the morning. The stored leaf was, as before, given a rapid wither in the chamber. The experiment was performed six times (once during the second flush, three times in the rains and twice in the autumnal period).

	Withered Naturally.	Stored and Withered.
Tocklai Taster ...	2/1/3	2/ -/11
Calcutta Panel ...	3/2/6	3/ 3/ -
London Panel ...	4/-/-	3/15/7
Average ...	3/1/3	3/1/2

No Taster finds any significant difference in valuation. On one occasion both the Tocklai Taster and the London Panel commented on a slight sourness detectable by nose on the infused leaf of the stored portion, which however was not noticeable in the liquor. On another occasion (23rd. November) the London Panel distinctly preferred the naturally withered leaf in cup as it had more autumnal flavour than the stored leaf; this opinion was not shared by the other Tasters.

(4) *Thick versus thin spreading.*

This experiment, the details of which have already been described, was performed four times (twice during the rains and twice in the autumnal period).

	Thick Spreading.	Thin Spreading.
Tocklai Taster	2/-/9	2/-/9
Calcutta Panel	3/5/11	3/5/5
London Panel	4/3/2	4/2/7**
Average	3/3/3	3/2/11

**Difference significant at the 1% level.

On all four occasions the London Panel valued the thick spread a fraction higher than the thin spread. The percentages of individual grades were almost identical in the two teas, and on no occasion did any of the Tasters find a substantial difference in appearance (including style) or in liquor.

Considering the four sections of this experiment together it is apparent that the system of withering contemplated at Tocklai has no ill effects on the leaf. When leaf is first stored overnight in suitable conditions and then withered at a thickness of 3½ lb. per square yard in 3-4 hours by means of a current of warm air, the resulting tea is equal in every respect to that made from leaf withered naturally in optimum conditions. Although the artificial wither is uneven to a certain extent because of its rapidity and also because of the thickness at which the leaf is spread this appears to be without effect on the finished tea. It is necessary to mention that in the experiment where leaf was stored in a plucking basket the purpose of the basket

was merely to maintain the leaf at a considerable thickness (10 to 12 inches), and during full-scale manufacture the use of plucking baskets for this purpose is not to be contemplated.

Duration of Withering.—An elaborate experiment conducted in 1953 led to somewhat inconclusive results owing to the difference of opinion among the Tasters. This year, instead of attempting to study in a general way the relationship between duration of withering and liquors a more specific approach was made in an endeavour to decide whether or not leaf storage is desirable in conjunction with tunnel withering.

Two treatments only were given :

(1) Leaf spread in the chamber at 3½ lb. per sq. yd. and withered immediately in 3 hours.

(2) Leaf stored on hessian 4 inches thick until above operation complete, transferred to the chamber at 3½ lb. per sq. yd. and left overnight without withering, then withered in 3 hours to same degree as first portion.

The leaf was the same for both treatments, being carefully mixed before dividing into the two portions (120 lb. each). Manufacture was by the C. T. C. process, all the leaf after a 30 min. roll being passed twice through the C. T. C. The experiment was performed on five successive days, producing a total of some 110 lb. of tea from each treatment. At the end of the week this was sorted into grades (five including dust) samples of which were distributed to Tasters. The surplus tea was stored in small chests, and further samples were taken after 10 weeks and after 16 weeks storage. The Tasters was asked to value all grades and to comment on their leaf appearance and liquors. The valuations tabulated below are averages calculated from the valuations and percentages of individual grades.

I. Freshly manufactured.

	Withered Immediately.	Withered after Storage.
Tocklai Taster	1/15/3	2/1/4
Calcutta Panel	3/2/.	3/-/5
London Panel	3/8/8	3/8/11
Average	2/14/-	2/14/3

The Tocklai Taster found the tea withered immediately too thin (one grade being green and raw) although preferable in briskness. The Calcutta Panel preferred the tea withered immediately on account of quality and briskness. The London Panel preferred the broken grades of the tea withered after storage for all-round cup characters. On the fannings and dust the preference, though slight, was in the opposite direction.

2. After ten weeks in chests.

	Withered Immediately.	Withered after Storage.
Tocklai Taster	2/-/11	2/1/11
Calcutta Panel	3/5/6	3/5/7
London Panel	4/10/8	4/8/11
Average	3/5/8	3/5/6

The Tocklai Taster's remarks were substantially the same as above. The Calcutta Panel could find no difference in liquor. The London Panel preferred the tea withered immediately for all-round cup characters.

3. After 16 weeks in chests.

	Withered Immediately	Withered after Storage
Tocklai Taster	2/3/11	2/3/10
Calcutta Panel	3/12/7	3/11/7
London Panel	4/10/4	4/10/2
Average	3/8/11	3/8/6

The Tocklai Taster still found the tea withered after storage to be stronger, more coloury and less brisk, but considered it to have passed its prime ; the tea withered immediately he considered to be still improving with age. The London Panel expressed precisely the same opinion as the Tocklai Taster and agreed that the tea withered immediately had kept better. The Calcutta Panel preferred the tea withered rapidly for colour and found it brighter and brisker.

Although the Calcutta and London Panels are not as consistent as the Tocklai Taster they do on the whole support him in his opinion that the tea withered immediately is brighter and brisker while that withered after overnight storage of the plucked leaf is stronger. This difference is precisely what would be expected from the figures for Condensation Index (not quoted) which in every case are higher for the tea withered after storage. and is the same as the Tocklai Taster's findings in the 1953 experiment. The valuation of these teas must remain largely a matter of personal preference as it is a question of deciding between the relative merits of a brisk, bright tea and a fuller more coloury tea ; some markets may pay higher prices for the former and others for the latter. The effect which maturing has had on these teas should be treated with some reserve until more knowledge has been gained on this subject, because for some reason which is not yet understood the changes undergone by Tocklai teas after manufacture are more rapid than is normally the case with commercial teas.

It is doubtful whether further experiments at Tocklai will yield any more information of a practical nature as to the desirability or otherwise of storing leaf prior to tunnel withering. The results of this experiment may be taken as an indication of what can he expected with leaf which arrives at the factory in good condition. Which tea fetches the better price can only be determined by experiment on individual gardens. If, as seems likely, there is no great difference between the two it will be largely a matter of convenience which alternative is chosen. On the other hand storage of leaf which arrives at the factory in a badly damaged condition may well prove harmful due to fermentation of the damaged portions, in which case better results will be achieved by omitting the storage. This again can only be decided by gardens for themselves. If desired, suitable timetables could be worked out to allow for storage of a portion only of each day's teaf, the balance being withered as soon as possible after receipt from the garden. This of course would lead to two different types of tea in each day's manufacture, but when mixed together these differences would disappear. The Tocklai Taster can find no difference between the taste of (1) a tea withered in 26 hours and (2) a blend composed of equal quantities of teas withered for 5 hours and 47 hours respectively, although these latter two by themselves are easily distinguished.

Withering Experiments in the Darjeeling District.—The results of the withering experiments described above, and those conducted at Tocklai in previous years, may reasonably be considered as applying to all plains districts in N. E. India. But the hill district of Darjeeling has to be treated separately in matters of manufacture because its teas are characterised by a flavour not present in those grown at a low elevation; and since this flavour largely determines the price of a Darjeeling tea it is essential that any change in normal manufacturing procedure should have no adverse effect on flavour. As a number of planters in the district had expressed interest in the possibilities of the Tocklai tunnel withering system it was decided to carry out some preliminary experiments in Darjeeling to test the effects of the type of withering on the teas. The Senior Biochemist visited Darjeeling in May, a period of the year when flavour is particularly apparent, and supervised experiments on five gardens. It was not possible to reproduce all the features of tunnel withering, but by spreading the leaf thinly the necessary wither was achieved in 3 to 5 hours (varying from 53% to 70% wither). Unfortunately the visit coincided with a shortage of leaf on some gardens, and the full experiment could only be performed four times (once each on two gardens and twice on a third). It consisted of the following treatments :

(1) Rapid wither. Leaf was withered in the shortest possible time by spreading near the bulking chamber, using either atmospheric air (twice) or heated air (twice), and was manufactured 6—9 hours after plucking.

(2) Normal wither. Leaf was withered overnight by natural air currents, the windows of the loft remaining open, and was manufactured the following day.

(3) Rapid wither after storage. Leaf was kept overnight in a shallow heap 6—8 inches thick. The following morning it was spread on the racks, withered in the shortest possible time and immediately manufactured.

Differences between the first and third treatment show the effect of chemical changes during the storage period. Differences between the second and third treatment show the effect of an accelerated wither and (where used) of hot air. Differences between the first and second treatment are due to a combination of all these factors.

Samples of the teas were reported on by the Panel of Brokers in Calcutta and by the Tocklai Taster. Neither found any consistent differences in appearance. Reports on liquors differed somewhat between gardens and between Tasters, but combining the four experiments both Tasters agreed that the normal wither was inferior to the other two. This was surprising, particularly on one garden where the loft temperature during normal withering averaged 75° and during the other two treatments was well over 90°. The Calcutta Panel throughout preferred the rapid wither to the rapid wither after storage whereas the Tocklai Taster on three occasions held the opposite view , however the difference between these two treatments was obviously not as marked as in the case of similar experiments using Tocklai leaf, and chemical examination showed the two to be very similar.

On two other gardens, where storage of leaf prevented the entire experiment from being performed, two out of the three treatments were given, omitting the rapid wither on one occasion and the rapid wither after storage on the other occasion. The Calcutta Panel on both occasions gave a marked preference to the liquor of the normal wither ; and although this opinion was not shared by the Tocklai Taster, who found little difference in the liquors, it is a contradiction which cannot be overlooked. However it is considered that the encouraging results obtained on four out of the six occasions provide ample justification for further experiment by those interested on a full commercial scale. A small version of the Tocklai withering tunnel could be constructed for this purpose, and even if experiments showed that this form of withering did not produce results equal with those obtained in the existing loft system it would still be a valuable supplement to withering during peak periods.

Physical Tests.—Physical tests have mainly been concerned with measuring the drop in hygrometric difference between one end of the chamber and the other, using various combinations of air speed and relative humidity, when leaf is spread on all trays of the three campartments at 3½ lb. per square yard. Air, as it passes over successive trays of leaf, picks up moisture and so loses its evaporative capacity, the dry bulb temperature falling and the wet bulb temperature remaining constant. Reversing the air flow for equal periods in each direction leads to uniform withering. The final proprtions of the withering tunnel and its

mode of operation have been based on these tests. In order to make as much use as possible of the evaporative capacity of the air conditions have been so arranged that the exhaust air is about 90% saturated. Under the particular conditions recommended—tunnel length 18 ft., air speed 350 ft. per min., hygrometric difference (inlet) 13·5°F—leaf loses weight at a rate of about 8·50% per hour. This figure can vary appreciably for different clones, but with commercial jats the variation is not likely to be great. The rate is affected by the standard of plucking, fine leaf withering more rapidly than coarse, and by the extent of damage of the fresh leaf, any damage leading to an acceleration of withering. Precise figures are not yet available. The figure of 8·5% is an average for Tocklai leaf of a medium standard of plucking and virtually undamaged. A similar figure has been recorded with commercial leaf of a much coarser standard damaged to a moderate extent.

Tunnel Withering : General Conclusion.—A system of withering has been evolved which, as far as moisture removal from leaf is concerned, can be guaranteed to give the results claimed. The effect of all stages of this system on the leaf appearance and liquor of the final tea has been tested as far as present facilities at Tocklai allow. An air temperature of 100° has practically no harmful effect even during quality periods. Thick spreading and rapid withering (3 to 4 hours) do not effect grade percentages, appearance or liquors. Leaf can remain overnight in the trolleys spread ready for withering, or can be left on the *chungs* of a leaf house at a fair thickness and be spread when required, without any adverse effect provided it is not extensively damaged when received from the garden. The permissible thickness of leaf in this latter case will depend on the prevailing temperature and so will vary with the time of year, but it would be as well to keep it below the point at which partial leaf reddening occurs. It would also be advisable to use "Kutched" hessian for this purpose. Results for the Darjeeling district are not a definite as those obtained at Tocklai, and would have to be confirmed on a commercial side before introducing the system extensively.

It should be noted that no improvement in teas is claimed as a result of the manner in which withering is achieved. The claim, so far as any claim can be made, is that leaf withered by this system to the same degree as leaf withered naturally is none the

worse for the treatment which it has received. The improvement would result from the fact that the tunnel system could give the desired degree of wither all through the season, whereas natural withering so often cannot. And the uniformity of wither which could be achieved by the tunnel system would make possible a complete standardisation of the entire manufacturing process.

Degree of Wither.—Since in tunnel withering any desired degree of wither can be obtained it is only reasonable to consider what degree of wither is most suitable for the plains. Expressing the wither in terms of the moisture content of the withered shoots, Tocklai have in the past recommended a wither to about 68% moisture content. This is well suited to conventional manufacture, as fairly hard pressure can be applied in the second roll without expressing large quantities of juice. A moisture of more than 68% is not be contemplated except perhaps for C. T. C. manufacture where experience suggests that 70% moisture gives good results. In hill districs it is usual to aim at a much higher degree of wither ; for instance the average in Ceylon appears to be a moisture content of 56%, and in Darjeeling a figure of 60% is common in factories with efficient controlled withering.

It is known that an increase in the hardness of wither has to be accompanied by extra rolling if the teas are to retain their full strength. So a hard wither in the plains would necessitate increasiug the rolling machinery, but at the same time a decrease in firing machinery would be possible. In order to obtain some preliminary information concerning the effect on liquors an experiment was conducted comparing three different degrees of wither :

(1) Soft wither. Leaf withered to 69% moisture and given two 30 min. rolls.

(2) Medium wither. Leaf withered to 64% moisture and given three 30 min. rolls.

(3) Hard wither. Leaf withered to 58% moisture and given four 30 min. rolls.

This was done six times during the late rains and early autumnal season. After sorting each tea into a bulk grade sam-

ples were distributed to Tasters, who submitted their reports on the standard tasting form. Below are tabulated the averages for the six manufactures.

	Tocklai Taster			Calcutta Panel		
	Soft 2 Rolls	Medium 3 Rolls	Hard 4 Rolls	Soft 2 Rolls	Medium 3 Rolls	Hard 4 Rolls
Inf. Leaf	42	42	53	45	43	47
Colour	50	50	50	45	52	53
Strength	57	53	50	47	52	57
Quality	48	45	52	45	45	52
Briskness	58	57	48	45	48	52
Valuation	2/3/2	2/2/8	2/2/9	3/3/9	3/4/11	3/4/4

	London Panel			Average		
	Soft 2 Rolls	Medium 3 Rolls	Hard 4 Rolls	Soft 2 Rolls	Medium 3 Rolls	Hard 4 Rolls
Inf. Leaf	38	37	43	42	41	48
Colour	52	48	47	49	50	50
Strength	47	47	42	50	51	50
Quality	35	30	40	43	40	48
Briskness	40	37	43	48	47	48
Valuation	4/1/8	4/1/7	4/2/0	3/2/10	3/3/1	3/3/0

None of the above differences are significant. Although the hard wither was remarked on as being neatest in style this does not appear to have affected its valuation. The liquors of all three teas are generally similar.

As an extension to this experiment two further manufactures were done in November, comparing soft and hard withers only, sorting the teas into recognised grades. Naturally the grade percentages were entirely different in the two teas. Tasters

were asked for valuations and remarks on each grade, the figures below being averages for the teas as a whole.

	Soft 2 Rolls	Hard 4 Rolls
Tocklai Taster	2/3/3	2/3/11
Calcutta Panel	3/11/1	3/11/3
London Panel	3/9/10	3/9/11
Average	3/2/9	3/3/0

The grades of the hard wither were blacker and of better style than those of the soft wither, but the latter had rather more tip, on one occasion the liquor of the hard wither was preferred. on the other occasions that of the soft.

The results indicate that with the particular combination of withering and rolling treatments chosen there is little difference in the market value of the teas. However this would have to be confirmed in full-size rollers as the small machines at Tocklai are not exactly comparable with commercial rollers, being rather light on the leaf.

In order to work out the economics of a hard wither compared with a soft wither four factors would have to be taken into account —the cost and running expenses of the extra withering equipment, the extra rollers, the saving in dryers and the relative price of the tea. While the first is at present an unknown quantity it is not possible to work out the relative production costs. But the effect in terms of machinery of changing from a soft wither (68% moisture) and two rolls to hard wither (58% moisture) and four rolls would be that withering capacity would require increasing by about 60%, the number of rollers would have to be increased by about 50% and the number of dryers could be very nearly halved.

Survey of Relative Humidity.—As in 1953, recording of wet and dry bulb temperature has continued on seven tea estates. The table below shows the average hygrometric difference on four estates measured at (1) 6·30-7·30. (2) 12·00-13·30.

(3) 15 45-16.30. all times being I.S.T, Figures for Tocklai measured at (1) 7.00 and (2) 13.00 are included for comparison.

District.	Rainfall 1954	Period	Hygrometric (1)	(2)	Difference (3)
Western Dooars	201″	May-June	2·7°	6·3°	6·2°
		July-Sept.	2·5°	5·5°	4·5°
		Oct.-Nov.	3·3°	9·0°	6·0°
Eastern Dooars	213″	May-June	2·7°	5·3°	5·2°
		July-Sept.	2·3°	5·1°	3·7°
		Oct.-Nov.	2·3°	8·8°	4·0°
Assam North Bank	102″	May-June	1·9°	6·8°	5·9°
		July-Sept.	1·6°	6·5°	5·8°
		Oct-.Nov.	1·1°	8·1°	4·8°
Doom Dooma	106″	May-June	2·4°	6·4°	6·1°
		July-Sept.	1·5°	5·6°	5·4°
		Oct.-Nov.	2·0°	8·2°	7·0°
Tocklai	72″	May-June	2·5°	7·1°	
		July-Sept.	1·5°	6·4°	
		Oct.-Nov.	1·2°	7·8°	

The rainfall in the Dooars was much above average in 1954 whereas in 1953 it was well below average, and this is reflected in the humidity figures. But there is still comparatively little differene between districts, and conditions for natural withering in the Dooars during the rains do not appear to be much worse than in Upper Assam.

The Tocklai tunnel withering system requires air with a hygrometric difference of 13.5°. To achieve this figure atmospheric air has to be heated, and the dry bulb temperature of the heated air depends on the dew point of the atmosphere. When the dew point is calculated from the wet and dry bulb temperatures recorded on the above gardens it is found to be remarkably constant in different districts. August is the month of highest dew point which at mid-day averages 77.5°, 79°, 78.5°, 78° and 78 5° on the above four gardens and at Tocklai respectively. In May the dew point averages about 74° and in November about 63°. It is normally lowest in the early morning and

highest at mid-day or in the afternoon, but the diurnal range is small being about 2° from May to October and rather more in November. The highest dew point recorded on any one day is 81°. The following table shows the temperature to which air has to be heated to give a hygrometric difference of 13·5° at various levels of dew point.

Dew Point	Heated to :—	
	Dry Bulb	Wet Bulb
81°	98·5°	85·0°
79°	96·5°	83·0°
77°	95·0°	81·5°
75°	93·0°	79·5°
70°	89·0°	75·5°
65°	84·5°	71·0°
60°	81·0°	67·5°

So to obtain a hygrometric differences of 13·5° the temperature of the incoming air need never be raised above 98·5°. While early and late in the season the temperature will be considerably lower.

TASTING BRANCH

J. M. Trinick—Tea Taster

Staff.—Mr. J. M. Trinick returned to Tocklai after five months leave in the U. K. on the 14th April 1954.

Buildings.—The new tasting room built during 1953 and 1954 has been in use since May 1954. This room is a great improvement on the old office situated inside the Tocklai Factory. The new building has excellent North light and during the past season has been adequately furnished.

Tours.—At the request of the D. B. I. T. A. the Taster visited seven Darjeeling gardens between the 18th. and 25th. May 1954.

At the request of the Senior Advisory Officer, West Bengal, the Taster visited ten Dooars Estates for the purpose of studying Dooars "Rains" manufacture with special attention to the Leg Cut Method.

Twelve Assam gardens were visited by the Taster during the year in connection with tasting and manufacture.

Tasting.—Although approximately 1,020 samples were tasted during the season the number of samples representing factory experiments were considerably less compared to previous years. This is no doubt due to the satisfactory market conditions which continued throughout the season. It is unfortunate that the spirit to improve manufacture decreases as prices increase.

Lectures.—During the year the Taster gave a series of lectures on "Tea Manufacture" to students of the Assam Agricultural College.

Calcutta Tasting Panel.—The Taster attended four meetings of the Calcutta Tasting Panel during the season for the purpose of tasting and discussing Tocklai's Experimental Manufacture. These meetings have proved most useful and have helped to smooth out some of the differences in opinion which previously existed between the Calcutta Panel and the Tocklai Taster. Tast-

ing Teas "blind" can be a most uninteresting occupation and these meetings with the Panel have given the Tocklai Taster the opportunity of explaining the nature of the experiments being conducted and so enlivening the interest of the Panel in the work being carried out at Tocklai.

Continuous Roller.—A number of samples manufactured in the Continuous Roller being developed at Tocklai have been tasted during the season. Although the Roller is still in the experimental stages the following observations have so far been made by this Department.

1. The dry leaf is blacker but duller than that made by the C. T. C. process. The leaf may be termed as being "artificially black".

2. As in the C. T. C. process tip is destroyed.

3. Dry leaf carries a useful twist and appears to be easily sorted.

4. Leaf grades are abolished.

5. Infused leaf is inclined to be greenish.

6. Liquors lack the pungency and brightness of C. T. C. manufacture but have more colour and are slightly superior to orthodox manufacture in the Tocklai rollers.

The samples received in this Department have so far given the impression that the machine would be suitable for those plains gardens producing black, bread and butter teas.

PHYSICO-CHEMICAL BRANCH

Staff : N. G. Gokhale, B.Sc., Senior Physical Chemist.

During the period June-September the Senior Physical Chemist acted for the Director who was on leave.

Advisory work and Correspondence.—A large number of queries were received during the year from tea gardens regarding soil problems. In the cases of selection of nursery sites and extensions/areas due for uprooting and replanting, the usual routine tests were carried out on the soil samples received and from the results obtained, suitable advice was given to the gardens. A number of cases were referred to us of existing tea areas which were not doing well. Wherever inadequate drainage was suspected to be the cause of the trouble, field infiltration tests were carried out and suitable further advice was then given to the gardens. In this advisory work, close contact is being maintained with the Advisory Branch.

During the year, the following number of samples were actually analysed and reported on :

Soil samples	...	799
Other ,,	...	34
	Total	833

In all, 193 advisory reports were issued to tea gardens during the year and in addition 239 other letters were written.

Visits.—Visits were paid on 6 occasions to gardens in the Jorhat, Golaghat and Tezpur circles in connection with discussion of soil problems. The Senior Physical Chemist also attended the S. V. B. I. T. A. Annual Meeting at Silchar.

Soil Research.—*1. Effect of Sulphate of Ammonia treatment on the soil exchange complex :* Application of an acidifying fertiliser like Sulphate of Ammonia to the soil is known to increase soil acidity. To study the rapidity of action of Sulphate of Ammonia treatment on the soil exchange complex, an experiment was carried out using 5 soil samples, four of which were from non-tea-bearing areas and had pH above 6·0 and the fifth was a normal tea soil. The soils were leached continuously at a slow rate, in a closed system, the leaching agent being a normal solution of Sulphate of

Ammonia. The soil samples were analysed before the leaching commenced and also after successive stages of leaching. Results obtained are given below :

TABLE 1.

Data about soil samples used for the experiment :

	Diffloo	Oak-lands	Lama-bari	Nang-dala	Borbhetta
pH water extract	6·48	6·00	6·17	6·75	5·21
,, KNO_3 ,,	5·10	4·21	4·95	5·68	4·09
N % on dry weight	0·083	0·136	0·142	0·096	0·107
Loss on Ign. % on dry weight	3·41	5·21	4·36	1·91	3·91
Total b.e.c. m.e./100 gms. soil	7·10	9·24	7·18	3·04	5·32

TABLE 2

Effect of leaching :

	Soil	Original values	After bleaching continuously for	
			15 days	1 month
Total exchangeable metal cations, m.e./100 gm. soil	Diffloo	5·16	1·10	0·10
	Oaklands	2·16	1·40	0·15
	Lamabari	3·48	0·50	0·19
	Nangdala	3·55	0·40	0·15
	Borbhetta	2 99	0·50	0·19
Exchangeable calcium, m.e./100 gm. soil	Diffloo	2·45	0·16	nil
	Oaklands	1·22	0·10	nil
	Lamabari	2·21	0·26	nil
	Nangdala	1·82	0·16	nil
	Borbhetta	1·43	0·10	nll
% Base saturation (calculated)	Diffloo	73	15	1
	Oaklands	23	15	2
	Lamabari	48	7	3
	Nangdala	F. Sat. ?	13	5
	Borbhetta	56	9	4

The rapid diminution in the total exchangeable metal cations may be noted. Calcium was the most easily lost cation and at the end of a month's leaching, no exchangeable calcium could be detected in the soil.

The drastic treatment given here does not of course occur under field conditions. What actually takes place in the case of the tea soils is complicated, on account of the regular addition of organic matter to the soil in the form of pruning litter and the droppings from shade trees, green crops etc. This results in a circulation of nutrients, the top layers of the soil being enriched at the expenses of the deeper layers. The tea soils are clearly not undergoing as drastic a treatmsnt as in the experiment carried out; but nevertheless, with continuous use of Sulphate of Ammonia alone as the fertiliser, one can but expect some similar changes in the soil exchange complex, in the long run.

2. Contribution of organic matter to the exchange properties of soils— The organic matter fractions in soils exert influences on the physico-chemical properties of soils which are far out of proportion to their percentage by weight. It is well recognised that maintenance of an optimum level of organic matter in the soil is essential for maintenance of fertility, for good tilth, for optimum water holding capacity and so on. The present study was undertaken to obtain an estimate of the relative contribution made by soil organic matter to the total exchange capacity of soils. A number of widely differing soil samples from the various tea districts of N. E. India were used for the experiment. The exchange capacity of all samples was determined, with Ammonium acetate as the leaching agent, before and after treatment with 6% Hydrogen peroxide. All the organic matter is not destroyed by this peroxide treatment but the exchange capacity was nevertheless reduced by values varying between 11% and 56%. Carbon determinations were similarly carried out, by the wet digestion method, on all the samples before and after peroxide treatment. Assuming that no free carbon was present in the soils the organic matter fraction was then estimated from the above values by using the conventional conversion factor. Results obtained are given in table 3.

The percentage contribution made by the organic matter fraction to the total exchange capacity appears to vary with the nature and type of both the inorganic and the organic portions of the soil. On the average, the contribution of the organic matter fraction is about 30 times, weight by weight as compared to that made by the inorganic portion.

TABLE 3

Contribution of soil organic matter to b. e. c.

Soil Sample		Total exchange capacity % m.e./100 gms. soil			Organic matter % on dry weight		Estimated percentage total exchange capacity contributed by	
		Original	Treated	% reduction on treatment	Original	Treated	Inorganic fraction	Organic fraction
1		2	3	4	5	6	7	8
PATHINI (Cachar)	Bheel	21·64	15·50	28	13·24	5·99	48	52
KURTI (Dooars)	Grey Silty Loam	18·32	15·36	16	4·85	3·28	50	50
KHOWANG (Dibrugarh)	Upper Assam Sandy Loam	7·92	7·02	11	2·81	2·19	48	52
PAHARGOOMIA (Darjeeling)	Red Earths or Mountainous soil	19·40	5·90	56	4·37	1·60	11	89
MONDAKOOTIE (Darieeling)	—do—	9·42	4·26	55	4·55	1·45	19	81
SAGMOOTIA (Nowgong)	Lower Assam Sandy Loam	6·64	3·74	44	2·47	0·36	49	51
MAZBAT (Darrang)	Loam	7·92	5·00	37	3·14	0·46	57	43
DEOPANI (Sibsagar)	Mid Assam Loamy Sand	5·56	4·12	26	2·07	0·43	67	33

Climatology

1. Analysis of Tocklai rain showers 1953-54.—A self-recording rain-gauge was installed at Tocklai in April 1953 and except for certain short periods has been in continuous operation since then. From the records so obtained, very interesting information is available about the duration, the actual time and also the intensity of the different rain showers. The following summary is in respect of the data for the period April '53 to December '54, i.e., for twenty-one months and including two full rainy seasons.

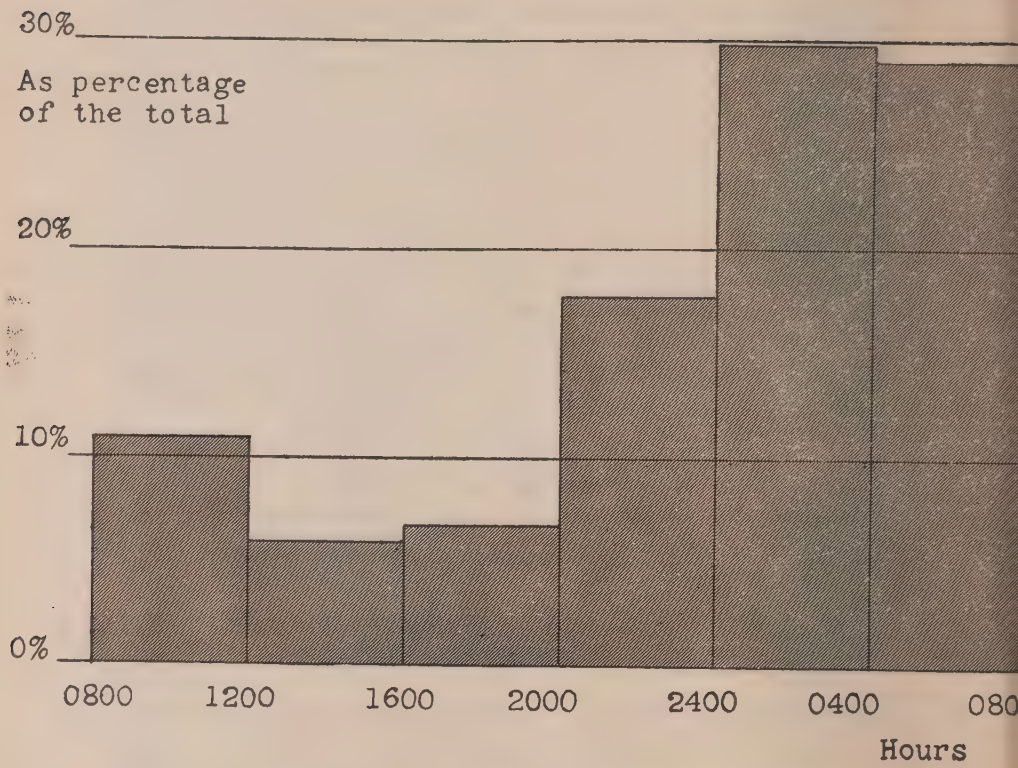
(*a*) *Hourly distribution of rainfall*—The rainfall which occurred during successive four hour periods starting from 0800 hours, i.e. rainfall between 0800 hours and 1200 noon, between 1200 and 1600 hours etc., was read off from the daily rainfall charts and the results obtained are given in table 4 and figure 1.

TABLL 4.

Hourly distribution of rainfall.

Month	Rainfall in inches during the hours						Total
	0800-1200	1200 1600	1600-2000	2000-2400	2400-0400	0400-0800	
1953 April	0·57	0·76	0·40	1·27	2·30	0·33	5·63
May	2·43	0·28	0·39	0·98	3·59	4·91	12·58
June	0·39	0·51	0·77	0 29	4·99	2·07	9·02
July	0·07	0·77	2·30	2·58	5·56	1·72	13·00
August	0·68	0·00	0·10	1·06	3·74	3·05	8·63
Sept.	2·32	1·10	1·17	1·93	3·15	4·19	13·86
Oct.	0·10	0·14	0·38	0·07	2·02	0·82	3·53
Nov.	0·00	0·00	0·00	0·00	0·00	0·04	0·04
Dec.	0·01	0·00	0·01	0·29	0·09	0·06	0·46
1954 Jany.	0·02	0·27	0·20	0·09	0·21	0·00	0·79
Feb	0·01	0·26	0·35	0·37	0·27	0·04	1·30
March	0·63	0·14	0·02	1·38	0·19	1·18	3·54
April	2·18	0·76	0·10	1·95	3·73	2·64	11·36
May	2·31	0·71	1·15	4·34	1·89	4·43	14·83
June	0·96	0·56	0·60	2·15	4·36	3·86	12·49
July	0·47	0·46	0·35	3·11	0·81	5·53	10·73
August	0·83	0·81	0·09	1·50	1·61	2·97	7·81
Sept.	0·79	0·08	0·16	0·24	0·91	1·21	3·39
Oct.	0·36	0·46	0·74	0·59	1·65	1·11	4·91
Nov.	0·04	0·00	0·00	0·00	0·00	0·00	0·04
Dec.	0·02	0·10	0·22	0·25	0·28	0·08	0·95
Total	15·19	8·17	9·50	24·44	41·35	40·24	138·89
% Actual	10·9	5·9	6·8	17·6	29·8	29·0	100·0
% Cumulative	10·9	16·8	23·6	41·2	71·0	100·0	

Figure 1 : Hourly distribution of rainfall.



It will be seen that over three fourths out of the total rainfall at Tocklai occurred during the hours 2000 to 0800.

(*b*) *Duration of rain.*—The actual duration of each rain shower was read off from the daily charts and monthly totals are tabulated in table 5.

TABLE 5.

Total duration of rainfall in hours.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1953	*	*	*	32.47	54.52	29.15	65.60	40.00	48.62	13.42	0.58	5.67
1954	11.00	7.75	12.73	27.97	32.63	63.70	42.92	46.95	17.58	58.23	0.67	16.72

*Recording raingauge was not installed.

The total rainfall during the period under review was below normal and it has already been mentioned that the recording raingauge was not working for certain short periods. The figures in table 5 are therefore a little on the low side but, nevertheless, they do give some idea of what does actually occur at Tacklai. It is interesting to note that the maximum duration of rain so far recorded in any one month was about 65½ hours, i.e., an average of just over 2 hours of rain per day. The average duration of rain during the period under review was about 30 hours per month which means that it rained for just over 4% of the time.

(c) *Intensity of rainfall*—In soil moisture studies, it is not enough to know merely the amount of rain which falls but information is also required about the rate at which it falls. The quotient (Amount rain : Time) known as Rain Intensity is of great importance in Soil Science on account of its influence on the intake of rain water into the soil and its subsequent loss by drainage and also on the erosive power of surplus water. Although factors such as the capacity of the soil to absorb rain water, the moisture content and other physical properties of the soil have also to be taken into consideration, nevertheless, speaking broadly, it may be taken that both the very light as well as the very heavy showers are almost wholly ineffective in so far as water requirements of plants growing in the soil are concerned. Unless the rainfall occurs within certain optimum rates of intensity, rain water either doesn't penetrate deep enough into the soil or else it may rain so hard that the water is readily lost as surface wash or in drainage. An analysis of the rainfall, according to categories of rain intensity, is therefore or some considerable interest in soil moisture studies.

Data for the period April '53-December '54 shows that the average rain intensity (i.e. total rainfall divided by the total time during which rain fell) at Tocklai was about 21 cents per hour, which is comparable to the figures recorded at the low altitude stations in the tropics. Very high rates were recorded for short durations and the following figures of the maxima reached are interesting.

TABLE 6

Absolute recorded maxima of rain intensity in various short periods.

During a period	5 min.	30 min.	45 min.	2 hrs.
Rainfall in cents	34	147	160	312
Rain intensity in cents/hour	408	294	213	156
Occurred on	21st April 1954	13th Oct, 1953	19th Aug. 1953	14th July 1954

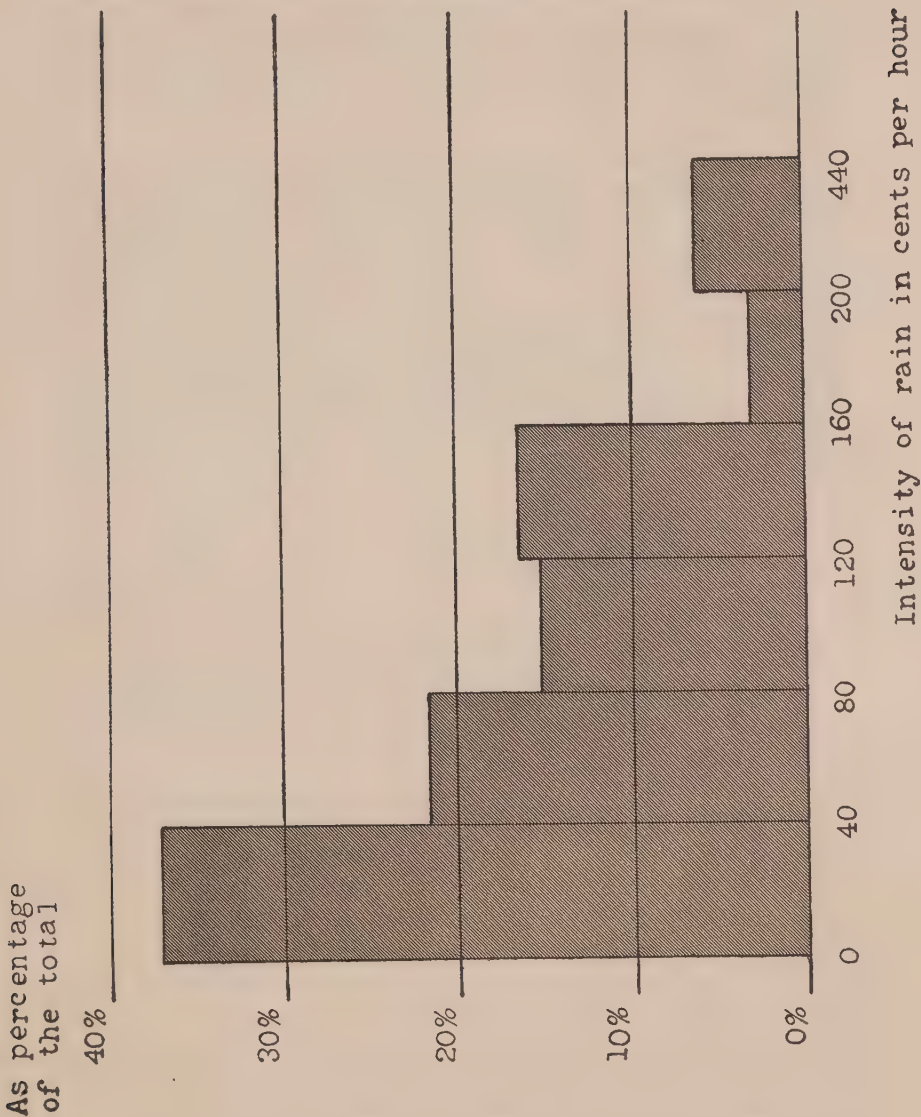
The different rain showers were classified according to certain categories of rain intensity and the monthly totals for each category are given in table 7.

TABLE 7

Rainfall (in cents) according to rain intensity (in cents/hour)

month	Categories of rain intensity in cents per hour						Data not available
	0-40	40-80	80-120	120-160	160-200	Over 200	
1953 April	257	120	58	60	0	68	
May	428	381	111	307	31	0	
June	237	121	83	416	45	0	
July	386	233	412	201	68	0	
Aug.	342	215	0	146	0	160	
Sep.	305	481	206	163	0	0	231
Oct.	107	91	8	0	0	147	
Nov.	4	0	0	0	0	0	
Dec.	46	0	0	0	0	0	
1954 Jan.	70	0	0	9	0	0	
Feb.	54	54	0	0	0	22	
Mar.	118	56	20	0	68	92	
Apr.	258	194	145	146	130	76	187
May	307	387	216	182	94	172	125
June	578	202	278	155	0	0	36
July	365	163	233	312	0	0	
Aug.	336	120	151	116	0	12	46
Sep.	156	29	65	0	0	89	
Oct.	421	10	39	0	0	0	21
Nov.	4	0	0	0	0	0	
Dec.	93	2	0	0	0	0	
Total	4872	2859	2025	2213	436	838	
% Actual	36·8	21·6	15·3	16·7	3·3	6·3	
% Cumulative	36·8	58·4	73·7	90·4	93·7	100·0	

Figure 2: Rainfall according to categories of rain intensity.



Just over a third of the total rain fall at intensities less than 40 cents/hour and roughly a quarter was at intensities so high as to be largely ineffectual.

2. ***Weekly normals of climate at Tocklai.***—Tables of weekly Tocklai normals for

(i) Maximum and minimum temperatures
(ii) Rainfall
(iii) Sunshine hours

have been prepared from the meteorological data recorded at the station during the years 1918 to 1953. The weeks are the standard weeks used by the India Meteorological Department. A month is too long an interval and the advantages of weekly figures are obvious.

3. Tocklai meteorological observation, 1954.—The rainfall was scanty until the 27th March but from that date onwards there was considerable rain until the end of May. During the period July-September the rainfall was well below normal with the result that the yearly total was some 10l below average. The number of wet days during the year were however not below normal. The average temperatures as well as sunshine hours were, on the whole, lower during the rains but higher in the early part of the year and towards the end. Full details are given in tables 8 to 11.

TABLE 8

1954	Monthly average temperatures of		Sunshine in hours (daily average)	Rainfall (inches)	Wet days	Average for 37 years	
	Max.	Min.				Rainfall (inches)	Wet days
Jan.	70·6	47·2	6·0	0·79	5	0·88	5
Feb.	78·8	55·5	6·7	1·30	8	1·31	8
Mar.	83·6	59·0	6·9	3·54	6	3·54	11
Apr.	80·9	67·3	4·6	11·36	24	7·83	17
May	86·0	72·1	5·4	14·83	18	10·70	20
June	88·2	75·3	4·2	12·49	25	12·89	23
July	88·9	76·0	4·6	10·73	30	14·99	25
Aug.	88·6	76·6	4·9	7·81	25	12·94	23
Sep.	89·2	76·0	6·2	3·39	14	10·60	20
Oct.	82·5	69·8	4·4	4·91	15	4·48	12
Nov.	79·4	57·8	6·6	0·04	2	1·07	4
Dec.	73·1	51·0	6·0	0·95	5	0·42	3
Total			66·5	72·14	177	81·65	171
Aver-age	82·5	65·3	5·5				

TABLE 9

%Relative Humidity (monthly averages).

1954	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
8 a.m.	93	90	85	91	88	89	90	92	92	94	93	94
2 p.m.	60	50	42	72	70	75	75	76	73	72	62	62

TABLE 10

Vapour Tension in inches of mercury (monthly averages).

1954	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
8 a.m.	.361	.469	.527	.695	.811	.893	.905	.938	.919	.767	.541	.404
2 p.m.	.416	.475	.445	.722	.827	.903	.931	.957	.920	.764	.588	.464

TABLE 11

Soil Temperatures °F, Soil Moisture and Evaporation from a standard evaporimeter

1954	Soil temperature at 1 ft.				Soil temperature at 3 ft.				Soil moisture % (top 9")	Evaporation (inches) daily mean
	Fallow		Grass		Fallow		Grass			
	8 a.m.	2 p.m.	8 a.m.	2 p.m.	8 a.m.	2 p.m.	8 a.m.	2 p.m.		
Jan.	63·3	63·8	64·2	64·4	63·9	68·9	68·1	68·0	12·3	0·050
Feb.	68·2	68·1	68·1	67·9	69·7	69·6	69·4	69·2	11·0	0·091
Mar.	73·2	73·0	72·2	72·4	72·9	73·0	71·3	73·1	10·7	0·145
Apr.	76·5	76·7	76·9	77·2	75·1	75·3	76·5	76·9	17·4	0·138
May	81·5	81·3	82·4	82·3	77·8	77·8	81·2	81·1	17·9	0·160
June	84·5	84·2	85·3	85·0	81·0	81·0	84·3	84·2	18·8	0·140
July	85·2	84·9	86·2	86·1	82·4	82·4	85·2	85·2	18·4	0·147
Aug.	85·3	85·0	86·5	86·3	83·3	83·2	85·4	85·3	18·9	0·104
Sep.	86·5	86·2	87·5	87·3	85·8	85·8	86·6	86·6	16·2	0·118
Oct.	81·0	80·6	81·7	82·3	83·1	82·8	83·2	83·0	17·2	0·084
Nov.	73·8	73·7	75·5	75·5	78·1	78·2	77·3	77·3	15·4	0·039
Dec.	67·2	67·0	68·6	68·4	72·5	72·5	71·1	71·1	13·5	0·054

ENTOMOLOGICAL BRANCH.

Staff.—G. M. Das, M.Sc., D. I. C., Ph.D.—Senior Entomologist.

Mr. D. K. Dutta, M.Sc., joined this Branch on 23rd July as Assistant Entomologist.

General.—The incidence of Red spider was unusually low almost throughout Assam at the beginning of the year, but its outbreak was noticed later in certain gardens. 'Sewing blight' occurred in a neighbouring garden affecting 40 acres of tea for a short while. This was discovered to be caused by a Hymenopterous fly in the act of oviposition. Looper attack was mostly confined to Bor medeloa trees which were badly defoliated. A hairy caterpillar of a Sasiocampid moth, *Cosmotriche-taeta* Wlk. was recorded for the first time to have defoliated Bor medeloa trees in a number of gardens in Sonari Circle.

Looper caterpillar.—Looper caterpillar appeared in large numbers in many gardens in Jorhat and Golaghat Circles which have mostly Bor medeloa shade. In most of these gardens, Bor medeloa trees had been badly defoliated, but the tea suffered negligible damage. This confirms our view that Looper is a jungle pest having Bor medeloa as one of the major host plants and it is this shade that is primarily responsible for bringing the pest into tea areas (vide Annual Report 1952, pp.57-58). Migration from gardens having Bor medeloa shade to neighbouring gardens without Bor medeloa can naturally be expected when tea is an alternative host.

Sewing blight.—The characteristic damage known as 'Sewing machine blight' was discovered to be caused by a Hymenopterous (Chalcid) fly in the act of oviposition. The eggs are laid in the tissues of young leaves and buds in several rows, each row containing a hundred or more eggs. The larva which is exceedingly small is a migratory form adapted to seek out the host upon which it preys. The larvae have been noticed to predate on Thrips and Jassids.

The leaves damaged in the act of oviposition are said to wither earlier than the healthy leaves ; otherwise, the insect is a beneficial one which destroys a large number of minute tea pests such as Thrips and Jassids. An article on 'Sewing blight' was published in 'Newsletter', Vol. 1, No. 3, p. 12.

Lasiocampid caterpiller.—A hairy caterpillar of a Lasiocampid moth caused considerable damage to Bor medeloa shade trees in a number of gardens in Sonari Circle. The moth has been identified as *Cosmotriche laeta* Wlk. When full-grown, a large number of caterpillars drop on to tea and pupate in white spindle-shaped cocoons constructed of silk inter-woven with larval hairs, while others pupate on the shade trees. In addition to the damage caused to Bor medeloa shade, the presence of a number of caterpillars and cocoons on tea bushes is troublesome to pluckers as it is impossible to go into areas underneath the infested Bor medeloa trees without being severely stung by them. It was reported that several persons had to be admitted daily to hospital with swollen hands and legs caused by touching or treading on the caterpillars and cocoons while working in the field, and one garden had 155 pluckers attend hospital in one day for this trouble only. The life-history of the pest will be studied if opportunity arises.

Psyllids.—A small field trial was conducted at Tyroon Tea Company against Psyllids attacking *Albizzia odoratissima* nursery plants with Verindal Ultra (Lindane) and ɣ isomer BHC 20% emulsion, at 1 in 1000 and 1 in 2000 parts of water and both were reported to be highly effective. Hardly any Psyllid could be found on the seedlings one month after the treatment.

Noctuid caterpiller.—A field trial was conducted against the Noctuid caterpillar, *Rhesala moestalis*, attacking shade tree plants in nurseries at Cinnamara T. E., with DDT 50% W.P., BHC 50% W.P., BHC 5% Dust, and Lindane 20% miscible concentrate. All insecticides were found to be more or less equally effective against the pest but Lindane was found to give the best control.

Ants and their nests on tea bushes.—Tne problem of ants and their nests occurring on tea bushes was investigated and several species of ants attending Coccids and Tea Aphis or enclosing them in their nests, have been recorded.

1. Oecophylla smaragdina Fab.—This red ant occurs abundantly in Assam, occasionally nesting on tea bushes but is more common in tea seed baris. It encloses *Lecanium discrepans* Green in its nest. It is also found in association with *Eriochiton theae* which is common on stems of tea bushes, and may enclose this Coccid or some species of *Saissetia* in its nest which is situated nearby. The nest is constructed of a number of leaves drawn together fastened by means of a silken web.

2. Crematogaster (Aerocoelia) dohrni Mayr.—This ant encloses in its nest *Coccus formicarii* Green which attacks stems and shoots of tea bushes. The nest is brown or dark-brown in colour, constructed around the stem, mostly at the bifurcation of the branches. It contains a large number of cells similar to that of termites, with galleries leading to every direction. The material used in the construction of the nest mainly consists of small particles of semi-decomposed vegetable matter such as leaf, agglutinated together. A nest may be as big as one foot in diameter.

3. Crematogaster (Acrocoelia) sp.—This new species of *Crematogaster* has also been found to enclose *Coccus formicarii* Green in its nest. The nest is similar to that of *Crematogaster dohrni*, but appears to be darker in colour.

4. Polyrhachis affinis Sm.—This ant encloses a Mealy bug in its nest on tea bushes. The nest is constructed of a brown silky, cobwebby material, over which dry leaves, straw, grass etc., are closely and thickly laid and fastened to it. The walls of the cells are constructed of silken webbed papery lining.

5. Technomyrmex detorquens Walker.—This ant found in association with *Saissetia* sp., has its nest in the soil.

6. Technomyrmex modiglianii Em. S. sp. *elator* Ferel.—This ant is found to attend young stages of *Saissetia hemisphaeri ccm* but has its nest in the soil.

7. Pheidole sulcaticeps Roger, var. *punensis* For., 8. *Paratrechina* sp., and 9. *Meranoplus* sp.—These ants are found in association with *Saissetia nigra* Niet., but have their nests in the soil.

10. Crematogaster (Acrocoelia)sp.—This ant constructs a small nest of one or two leaves folded and tied up at the margins, imprisoning Tea Aphis, *Toxoptera aurantii*, in it.

The presence of ants and their nests on tea bushes creates a lot of difficulties to pluckers and to those who carry out the usual agricultural operations as it is almost impossible to pass by the side of such bushes without being severely bitten by ants.

The details of association of ants with Coccids and tea Aphis, have been described in an article published in "Newsletter', vol. 1, No. 2.

Buprestid attacking roots of shade tree plants in nurseries.—A trial was conducted with Aldrin, Dieldrin and Endrin at different concentrations as prophylactic treatments to nursery beds against *Sternocera aurosignata* at Rupajulie Tea Estate. But there was no incidence of the pest in the treated as well as in the check plots, and it is proposed to repeat the trial in some other gardens.

Pink and purple mites.—Preliminary studies on the life-history of Pink mite, *Acaphylla Steinwedeni*, Keifer., and Purple mite, *Calacarus carinatus* (Green) Keifer., were made in the months of July and August.

The duration of egg-stage of Pink mite is 2 to 3 days, and that of young stage 3 to 4 days. The life-history is completed in 5½ to 7 days.

The incubation period of Purple mite is 3 to 4 days and the duration of young stage 3 to 4 days. The life-history is completed in 6 to 7½ days.

Termite control.—The persistent toxicity of Aldrin and Dieldrin in the plots treated in 1952 at Tarajulie Tea Estate was estimated (1954) with the following results.

Persistent effect of Aldrin and Dieldrin—(Tarajulie 1952 Experiment)

Treatments	Number of earth runs in						Total
	March 1954	May 1954	July 1954	Sept. 1954	Nov. 1954	Jan. 1955	
Aldrin 50% W. P. @ 8 lbs. acre	11	9	7	4	94	84	164
Aldrin 50% W. P. @ 16 lbs./acre	0	4	3	2	25	30	64
Aldrin 23% E. C. @ 8 lbs./acre	5	6	5	4	59	66	145
Dieldrin 50% W. P. @ 8 lbs./acre	3	2	2	1	11	65	84
Dieldrin 50% W. P. @ 16 lbs./acre	3	4	0	6	5	45	63
Dieldrin 18·5% E.C. @ 8 lbs./acre	5	3	4	4	25	61	103
Check	40	33	29	28	222	153	505

From the above Table it would appear that residue of Aldrin @ 16 lbs. and Dieldrin @ 8 and 16 lbs. per acre persists even in the third year of treatment. As the experiment was not statistically designed and treatments were not replicated for want of sufficient insecticides it is not possible to ascertain definitely whether Dieldrin is significantly superior to Aldrin.

The persistent toxicity of Aldrin and Dieldrin was also estimated this year from a replicated trial conducted in 1953 at Tarajulie T. E. Obervations were made on alternate months, starting from March 1954.

Total of bi-monthly observations during the year 1954.

Average No. of earth runs per bush

Treatments	Mean of 5 replications
Aldrin 50% W. P. @ 16 lbs./acre.	2·70
Dieldrin 50% W. P. @ 16 lbs./acre	1·39
Gammexane D·025 @ 190 lbs./acre	5·82
Check (Untreated)	7·09

Mean C. D. 1·56

It appears that the persistent toxicity of Aldrin and Dieldrin is quite high and there is no significant difference between the two treatments. Gammexane is not found to be significantly superior to check. Observations in the year of application, however, showed Gammexane to be significantly superior to check though it proved to be significantly inferior to both Aldrin and Dieldrin. the last two being equally effective. It therefore appears that the toxicity of Aldrin and Dieldrin lasts in the soil for at least 20 months, if not more while that of Gammexane practically disappears in the second year of treatment.

As the rates of Aldrin and Dieldrin in the above trials were considered too high, further trials were conducted at Borjulie and Naharani Tea Estates to find out the optimum doses.

Borjulie Trial 1954

Treatment	Total number of bushes	Earth runs upto Oct. 54	Earth runs January 55	Total earths runs
Aldrin 50% W. P. @ 2 lbs/acre.	600	191	952	1143
Aldrin 50% W. P. @ 4 lbs/acre.	600	100	263	363
Dieldrin 50% W. P. @ 2 lbs/acre.	600	20	24	44
Dieldrin 50% W. P. @ 4 lbs./acre	600	12	16	28
Check.	600	325	2395	2720
Endrin 19·5% E. C. 1 in 500 parts of water @ 2lbs./acre	600	20	105	125
Endrin 19·5% E. C., 1 in 500 parts of Water @ 4 lbs./acre.	600	27	54	81

Dieldrin at both 2 and 4 lbs per acre gives very good control of termites. As this was not a replicated trial, it is not possible to estimate definitely whether Dieldrin is significantly superior to Aldrin or Endrin

Naharani Trial 1954

Treatment	Number of earth runs per bush Mean of 4 replications
Aldrin 50% W. P. @ 2 lbs./acre	... 0·11
Aldrin 50% W. P. @ 4 lbs./acre	... 0·03
Dieldrin 50% W. P. @ 2 lbs./acre	... 0·02
Dieldrin 50% W. P. @ 4 lbs./acre	... 0·01
Check	... 0·25

Mean C.D. 0·13

Both Aldrin and Dieldrin @ 2 and 4 lbs. per acre are equally effective against termites and there is no significant difference between the two treatments, and the rates of 2 lbs. and 4 lbs. per acre.

General conclusion.—Both Aldrin and Dieldrin 50% W.P. @ 2 and 4 lbs. per acre are effective against termites attacking tea. It is however, proposed to recommend Aldrin and Dieldrin 50%W.P. @ 4 lbs. (2lbs. actual) per acre for control of termites in flat areas for the present. It is assumed that persistent toxicity of these insecticides at this rate will remain effective for at least three years but this can only be established by observations in the coming years.

Tainting effect on made tea.—In an experiment, the plots were treated with Toxaphene W. P., Aramite, G.24353, Ovotran (Y. F. 3112) and Verindal Ultra (Lindane) plucked after one week. Our Tea Taster's report is given below.

Date of treatment 14-6-54

Treatments	Sample No.	Total rain fall	Comments
Toxaphene (40%) W.P. at 1 lb. 10 gals. of water	1 2	4·44"	Slight medicinal taste, may be character of leaf
Aramite 1 lb. in 50 gals of water	1 2	,, ,,	No taint No taint
G. 24353, 1 in 500 parts of water	1 2	,, ,,	No taint No taint
Ovotran (Y.F. 3112) 1 lb. to 50 gals. of water	1 2	,, ,,	Tainted Suspicious undercurrent, may be tainted
Verindal Ultra (Lindane) 1 lb. to 100 gals of water	1 2	,, ,,	Tainted Badly tainted
Check (Untreated)	1 2	,, ,,	No taint No taint

No taint was detected in tea made from the plots treated with Aramite and G.24353, whereas the others tainted the made tea.

Another trial was carried out with some important acaricides and two samples from each treatment were tested with the following results.

Date of treatment 14. 10. 54.

Treatments	Sample No.	Dt. of plucking 21/10/54		Dt. of plucking 28/10/54	
		Total rain-fall	Comments	Total rain-fall	Comments
Aramite, 1 lb. to 50 gals. of water.	1	0·15″	No taint.	1·38″	No taint.
	2	,,	,,		,,
Spersul, 1lb. to 10 gals. of water.	1	,,	Badly tainted.	,,	Tainted.
	2	,,	,, ,,	,,	,,
Thiovit, 1 lb. to 10 gals. of water.	1	,,	,, ,,	,,	Tainted
	2	,,	,, ,,	,,	Badly tainted.
Ialine Colloidal sulphur 1 quart to 100 gals. of water.	1	,,	Slight suspicion of taint		Thin suspected. taint.
	2	,,		,,	
Lime sulphur (Star Brand) 1 in 40 parts of water	1	,,	No taint	,,	No taint
	2	,,	,,	,,	,,
Ovotran (Y.F.3112) 1 lb. in 50 gals. of water	1	,,	Badly tainted.	,,	Badly tainted.
	2	,,	,, ,,	,,	Tainted.
Check	1	,,	No taint	,,	No taint.
	2	,,	,,	,,	,,

No taint could be detected in the tea made from Aramite and Lime sulphur treated plots. There was however, a slight suspicion of taint with Collodial sulphur, whereas Spersul, Thiovit and Ovotran badly tainted the made tea.

Tainting of tea packed in chests made of panels treated with DDT—A trial was carried out on taining of tea packed in chests made of panels treated with DDT.

No taint was however, detected in the tea packed in a DDT treated box with usual linings of foil and paper for three months after storing but in the third month, the tea tasted fruity and was out of condition probably due to repeated exposures to atmosphere while taking out the samples for tasting, whereas the tea packed in DDT treated box which had only paper lining or nothing at all, was found badly tainted and was also old and out of condition.

The trial had to be discontinued and a fresh one was conducted in co-operation with the Scientific Department, Jorehaut Tea Company, and samples will be tasted every three months.

Red spider control.—Laboratory trials* were conducted with Chlorocide (p-chlorobezyl p-chlorophenyl sulphide), an acaricide received from Boots Pure Drug Co., Ltd., Nottingham. This acaricide is said to have high ovicidal action and give effective control of certain spcies of Red spider.

Treatments.

A—Chlorocide W. P. 1 lb. in 40 gallons of water.

B—Chlorocide M. O. 1 in 400 parts of water.

C—Check.

Effect of Chlorocide on the eggs of Red spider.

Treatments	Total eggs	Eggs hatched	Eggs unhatched	Percent unhatched eggs
Trial No. 1				
A	183	92	91	49·7
B	180	156	24	13·3
C	179	175	4	2·2
Trial No. 2				
A	618	213	405	65·5
B	538	366	172	32·0
C	1119	1095	24	2·1

*In all laboratory trials, one infested shoot represents one replicate each treatment with five replications.

Chlorocide W. W. was found to give 50-60% egg mortality, while Chlorocide M. O. was much inferior to W. P.

Residual effect on freshly hatched larvae.—It was not possible to evalute definitely the persistent toxicity of Chlorocide to newly hatched larvae of Red spider as quite a large number of them were found missing from treated leaves. However, the following Table will show the number of freshly hatched larvae found killed on the leaves treated earlier.

Treatment	Total larvae	Larvae dead	Percent dead	Larvae living	Percent living	Larvae missing	Percent missing
A	213	76	35·7	42	19·7	95	44·6
B	366	98	26·8	170	46·4	98	26·8
C	1095	20	1·8	1045	95·4	30	2·7

Chlorocide appears to have moderate persistent toxicity to freshly hatched larvae of Red spider.

Penetration of Chlorocide.—Chlorocide is said to penetrate through the leaf tissue and affect the eggs on the other surface of the leaves. In an expermiment the undersurface of the leaves was brushed with spray of Chlorocide while there were eggs on the upper surface.

Treatments	Total eggs	Eggs hatched	Eggs unhatched	Percent unhatched eggs
A	454	418	36	7·9
B	217	214	3	1·4
C	345	344	1	0·3

A very small percentage of eggs may be affected by such penetration, if there be any.

In another experiment the upper surface was brushed with spray of Chlorocide, and adult Red spiders were introduced on the under surface. They however moved to the upper surface and laid eggs there.

Treatments	Total eggs	Eggs hatched	Eggs unhatched	Percent unhatched eggs	Larvae found killed on the leaf	Percent of larvae found killed on leaf
A	273	234	39	14·3	18	7·7
B	253	343	10	2·8	7	2·0
C	282	279	3	1·1	0	0·0

Only a small percentage of eggs were affected on the leaves treated with Chlorocide W.P., while percentage of egg-mortality was too low with M. O. Only about 8% of the larvae emerging from the unaffected eggs were killed by the persistent toxicity of W. P. and 2% by that of M.O.

Effect on quiescents

Treatments	Total quiescents	Quiescents moulted	Quiescents not moulted	Percent killed
A	13	4	9	69·2
B	88	4	84	95·5
C	86	85	1	1·2

Chlorocide was found to be highly effective against quiescent forms but M. O. gave more kill than W. P.

Effect on active forms

Treatments	Total active forms	Active forms killed	Percent killed
A	221	7	3·2
B	281	49	17·4
C	365	1	0·3

Chlorocide W. P. was found to have practically no effect on active forms (larvae, nymphs and adults) of Red spider. A small percentage of kill can however be obtained with M. O.

It may be mentioned in this connection that quiescents formed immediately after the application of Chlorocide are more affected than those formed just before the treatment.

In a further trial against adult Red spiders, the results were almost similar to that obtained in the previous trial against active forms (larvae, nymphs and adults).

Treatments	Total adults	Adults killed	Percent killed	Adults living	Percent living	Adults migrated	Percent migrated
A	109	7	6·4	83	76·1	19	17·4
B	101	16	15·8	36	35·6	49	48·5
C	107	4	3·7	96	89·7	7	6·5

Conclusion.—As the Red spider occurs on tea throughout the year and all the stages can be found there at any time of the year, the present formulations of Chlorocide are not likely to be of much use in controlling it.

Lethalrock-M-25/S-25—An acaricide of Flintrock Products Ltd., containing p-chlorophenyl p-chlorobenzene sulphonate 25% plus wettable sulphur 25%, was tested against various stages of Red spider under laboratory conditions.

Treatments.

A—Lethalrock M-25/S-25 at 1 lb. to 40 gals. of water.

B—Check.

Effect on the eggs

Treatments	Total eggs	Eggs hatched	Eggs unhatched	Percent unhatched eggs
Trial No. 1				
A	485	413	72	14·8
B	438	438	0	0·0
Trial No. 2				
A	518	472	46	8·9
B	921	911	10	1·1

Residual effect on newly hatched larvae

Treatments	Total larvae	Larvae killed	Percent killed	Larvae living	Percent living	Larvae migrated	Percent migrated
A	472	147	31·1	310	65·7	15	3·2
B	911	0	0·0	898	98·6	13	1·4

Effect on quiescent froms

Treatments	Total quiescent	Quiescents not moulted	Percent killed
A	149	70	47·0
B	64	0	0·0

Effect on active forms

Treatments	Total active forms	Active forms killed	Percent killed	Active forms living	Percent living	Active forms migrated	Percent migrated
A	361	165	45·7	18	5·0	178	49·3
B	511	30	5·9	457	89·4	24	4·5

Conclusion.—From the above results it is evident that Lethalrock M-25/S-25 is not likely to prove effective in controling tea Red spider. It gave only moderate kill of active and quiscent forms, and most of the unaffected active forms dropped from the treated leaves. Some of those when kept on fresh leaves survived and deposited eggs.

The egg-mortality obtained with Lethalrock M-25/S-25 was as low as 9-15% and this is far less than what could be expected from an acaricide containing p-chlorophenyl p-chlorobenzene sulphonate. It may be mentioned in this connection that the egg-mortality obtained in our tests with 'Ovotran' and 'Y.F. 3112' oontaining the same toxic ingredient but without sulphur at the same concentration was 80-90%.

'Murvesco' containing Parachlorophenyl benzene sulphonate received from Messrs. Murphy Chemical Ltd., was tested against various stages of Red spider under laboratory conditions.

Treatments

A—Murvesco miscible concentrate, 1 in 400 parts of water.
B—Check.

Effect on the eggs.

Treatments	Total eggs	Eggs hatched	unhatched eggs	Percent unhatched eggs
Trial No. 1				
				15·0
A	387	329	58	0·0
B	438	438	0	
Trial No. 2				
				9·0
A	531	483	48	1·1
B	921	911	10	
Trial No. 3				
				9.5
A	546	494	52	4·4
B	564	539	25	
Trial No. 4				
				13·8
A	412	355	57	2·1
B	389	381	8	

Residual effect on newly hatched larvae

Treat-ments	Total larvae	Larvae killed	Percent killed	Larvae living	Percent living	Larvae migra-ted	Percent migra-ted
A	483	19	3·9	460	95·2	4	0·8
B	911	0	0·0	898	98·6	13	1·4

Effect on quiescent forms

Treat-ments	Total quiescents	Quiescents not moulted	Percent killed
A	83	36	43·4
B	64	0	0·0

Effect on active forms

Treat-ments	Total active forms	Active forms killed	Percent killed	Active forms living	Percent living	Active forms migr-ated	Percent migr-ted
A	636	138	21·7	68	10·7	430	67·6
B	511	30	5·9	457	89·4	24	4·5

Conclusion.—Forms the above loboratory trials it appears that Murvesco Miscible Concentrate is slightly toxic to active forms and quiescent stages of Red spider. Most of the active forms however dropped from the leaves soon after treatment and some of them when kept on fresh leaves multiplied as usual. Only 9-15% eggs were affected. The persistent toxicity to newly hatched larvae was practically nil.

It appears that 'Murveso' Miscible Concentrate is not likely to prove effective against Tea Red spider.

'Y. F. 3112' containing p-chlorophenyl p-chlorobenzene sulphonate received from Messrs. Imperial Chemical Industries was tested against various stages of Red spider under laboratory conditions.

Treatments

A—Y. F. 3112 at 1 lb. to 25 gallons of water

B— ,, ,, 1 lb. to 50 ,, ,,

C— ,, ,, 1 lb. to 100 ,, ,,

D—Check

Effect on the eggs

Treatments	Total eggs	Eggs hatched	Eggs unhatched	Percent unhatched eggs
A	334	48	286	85·6
B	331	88	243	73·4
C	320	106	214	66·9
D	371	360	11	3·0

Effect on freshly hatched larvae.

Treatments	Total larvae	Larvae killed	Percent killed	Larvae living	Percent living	Larvae migrated	Percent migrated
A	48	22	45·8	0	0·0	26	54·2
B	68	29	42·6	1	1·5	38	55·9
C	104	22	21·2	14	13·5	68	65·4
D	360	1	0·3	316	87·8	43	11·9

Effect on quiescent forms.

Treatments	Total quiescent	Quiescent not moulted	Percent killed
A	28	7	25·0
B	25	4	16·0
C	21	2	9·5
D	16	0	0·0

Conclusion. –Y. F. 3112 was found to be highly effective against eggs and quite a high percentage of freshly hatched larvae were killed by persistent toxicity. But it was almost non-toxic to adults, nymphs and gave 9-25% mortality of quiescent stages. The question of combining it with another acaricide which is effective against active forms does not arise as Y. F. 3112 taints the made tea, and unless a non-tainting formulation is developed, there is little possibility of using it on leaf-bearing tea.

'G.24353' (ethyl ester of 4,4-dichloro-benzilic acid)—This acaricide was found to be highly effective against all stages of Red spider under laboratory conditions (vide Annual Report, 1952, pp.95-97). Further tests on eggs were made and its persistent toxicity to newly hatched larvae was evaluated during the year.

Treatments.

A—G.24353, 1 in 500 parts of water.

B—G.24353, 1 in 1000 parts of water.

C—Check.

Effect on eggs

Treatments	Total eggs	Eggs hatched	Eggs unhatched	Percent unhatched eggs
A	617	240	377	61·1
B	227	163	64	28·2
C	304	294	10	3·3

Residual effect on newly hatched larvae

Treatments	Total larvae	Larvae killed	Percent killed	Larvae living	Percent living	Larvae missing	Percent missing
A	240	168	70·0	14	5·8	58	24·2
B	163	98	60·1	4	2·5	61	37·4
C	294	1	0·3	277	94·2	16	5·4

Conclusion.—G. 24353 at 1 in 500 parts of water gave 61% egg-mortality. This is slightly less than what was obtained last year. A high percentage of freshly hatched larvae were killed by the residue.

'Aramite' (2-(p-tert-butylphenoxy) isopropyl 2-chloroethy sulfite)—This acaricide was found to be highly effective against all stages of Red spider (vide Annual Report, 1953, pp. 90-95). Further trials were conducted against eggs and active forms and its residual effect on newly hatched larvae was evaluated.

Treatments

A—Aramite at 1 lb. to 50 gallons of water.
B—Aramite at 1 lb. to 100 gallons of water.
C—Check.

Effect of Aramite on active forms.

Treatments	Total active forms	Active forms killed	Percent killed	Active forms living	Percent living	Active forms formed quiescents	Percent formed quiescents	Active forms migrated	Percent migrated
A	1079	824	76·4	0	0·0	17	1·6	238	22·1
B	676	413	61·1	3	0·4	15	2·2	245	36·2
C	635	15	2·4	572	90·1	20	3·1	28	4·4

Effect on eggs.

Treatments	Total eggs	Eggs hatched	Eggs unhatched	Percent unhatched eggs
A	390	100	290	74·4
B	525	345	180	34·3
C	347	328	19	5·5

Residual effect on freshly hatched larvae.

Treatments	Total larvae	Larvae killed	Percent killed	Larvae living	Percent living	Larvae missing	Percent missing
A	100	45	45·0	12	12·0	43	43·0
B	345	102	29·6	44	12·8	199	57·7
C	328	1	0·3	313	95·4	14	4·3

Effect on eggs sprayed on different dates.

TREATMENTS

(Aramite at 1 lb. to 50 gallons of water)

A—Sprayed within 24 hrs.

B— ,, ,, 48 hrs., but after 24 hrs.

C— ,, ,, 72 hrs., but after 48 hrs.

D— ,, ,, 96 hrs., but after 72 hrs.

E— ,, ,, 120 hrs., but after 96 hrs.

F—Check.

Treatments	Total eggs	Eggs unhatched	Percent unhatched eggs
Trial No. 1			
A	1026	905	88·2
B	692	485	70·1
C	610	496	81·3
D	737	136	18·5
E	...	...	...
F	619	18	2·9
Trial No. 2			
A	401	368	91·7
B	461	366	79·3
C	603	501	83·0
D	...	...	...
E	...	...	...
F	706	13	1·8

Treatments	Total eggs	Eggs unhatched	Percent unhatched eggs
Trial No. 3			
A	592	571	96·5
B	450	436	96·9
C	482	440	91·3
D	334	120	35·9
E	...	...	...
F	273	3	1·1
Trial No. 4			
A	916	832	90·8
B	811	741	91·3
C	961	887	92·2
D	877	561	64·9
E	879	89	10·1
F	854	22	2·5

Probable effect of rain on the ovicidal action

TREATMENTS

(Aramite at 1 lb. to 50 gallons of water)

A—Washed for 5 minutes after 2 hrs.

B— ,, ,, ,, ,, 4 hrs,

C— ,, ,, ,, ,, 6 hrs

D— ,, ,, ,, ,, 12 hrs

E— ,, ,, ,, ,, 24 hrs

F—Not washed.

G—Check (Sprayed with water only)

Treatments	Total eggs	Eggs unhatched	Percent unhatched eggs.
A	102	26	25·5
B	285	75	26·3
C	394	103	26·1
D	290	89	30·7
E	126	62	49·2
E	244	145	59·4
G	261	20	7·7

Conclusion—These trials confirmed our last year's finding that Aramite is highly effective against active forms and eggs of Red spider. As regards its ovicidal action, time factor i. e. the interval between the date of egg-laying and the date of spraying appears to have some influence on its efficacy and a series of trials were conducted to investigate this point. It appears that there is practically no difference in the efficacy of Aramite if sprayed within 72 hours of egg-laying, but the percentage of egg-mortality is considerably reduced when sprayed shortly before hatching.

To find out the effect of probable rain a trial conducted by washing the acaricide from treated leaves with plain water by means of a low volume hand sprayer at different intervals showed that the ovicidal action of Aramite is considerably reduced if it rains within 12 hours of treatment.

About 45% of the newly hatched larvae on the treated leaves were killed by the residue and the rest migrated.

Field trials—Red spider control

Cinnamara Tea Estate

Treatments

A—Chlorocide W. P., 1 lb. to 40 gallons of water.

B.—Chlorocide M. O., 1 in 400 parts of water.

C—Lime Sulphur, 1 in 40 parts of water.

D—Aramite, 1 lb.to 50 Gallons of water.

E—Chlorocide 1 lb., plus Lime Sulphur 1 gallon plus water 40 gallons.

F.—G. 24353, 1 in 500 parts of water.

G.—Check.

Each treatment with 4 replications.

Two rounds of spraying were done.

1st application on 1/2-54.

2nd application on 17/18-2-254.

Observation on 4-3-54 (after 2nd application)

Treatments	Living Red spider per 40 leaves	Percent Red spider reduction over check
A	2483	54·2
B	3704	31·7
C	120	97·8
D	282	94·8
E	54	99·0
F	788	85·5
G	5426	...

Even two applications of Chlorocide W. P. and Chlorocide M, O. did not give satisfactory control of Red spider. There was very little difference between the treatments of lime sulphur alone and lime sulphur plus Chlorocide W. P., the former giving 97·8% reduction in population over check. Aramite alone gave effective control of Red spider, whereas the reduction obtained with G.24353 was highly satisfactory.

Silcoorie Tea Estate

TREATMENTS

A. Aramite 1 lb. plus Spersul 5 lbs. to 50 gallons of water.

B. Chlorocide W. P. 1 lb. to 40 gallons of water.

C. Chlorocide W. P. 1 lb. plus Spersul 4 lbs. in 40 gallons of water.

D. Lime sulphur (Standard) 1 in 40 parts of water (1 : 40)

E. G.24353 at 1in 500 parts of water (1:500)

F. Check (Untreated)

This was not a replicated trial and only one application of acaricides was made.

The treatments were applied by means of Pressure Retaining Knapsack Sprayers using low volume nozzles.

Affected Red spiders found on 20 leaves collected at random from each treatment 24 hrs. after application

Treatments	Red spiders living	Red spiders killed
A	1	1565
B	1116	254
C	4	1335
D	6	1331
E	39	1157
F	1408	6

Affected eggs found on 10 leaves from each treatment after the incubation period is over.

Treatments	Eggs unhatched
A	1556
B	426
C	783
D	481
E	842
F	24

Red spider population found on 20 leaves collected at random 1 month after treatment.

Treatments	Red spider living	Percent reduction over check
A	9	95·4
B	162	16·5
C	16	91·8
D	139	28·4
E	54	72·2
F	194	...

Yield up to October, 1954, from the date of spraying (21. 5. 54).

Treatments	Yield
A	2 mds. 16 lbs.
B	1 md. 62 lbs.
C	1 md. 72 lbs.
D	2 mds. 6 lbs.
E	2 mds. 6 lbs.
F	1 md. 62 lbs.

From the above tables it is evident that Aramite plus Spersul gives the best control of Red spider. Chlorocide plus Spersul was almost equally effective as Aramite plus Spersul, but Chlorocide alone was practically useless. G.24353 gave satisfactory control of Red spider. Considerable initial reduction was obtained with one application of lime sulphur but the population was built up from the unaffected eggs after some time. Two applications of lime sulphur are therefore necessary for control of Red spider on flushing tea.

A series of field trials (not replicated) with Aramite, Chlorocide, G. 24353 alone or in combination with wettable or colloidal sulphur were conducted at Tocklai and Borbhetta and the results of only three trials are as follows.

1. Date of 1st application—25-1-54.
   Date of 2nd application—10-2-54.
   Date of observation —26-2-54.

Treatments			Red spider populatio
Aramite at 1 lb. to 50 gallons of water.		One application.	152
do	do	Two applications.	5
Check.			836

2. Date of application—16-2-54.

Date of Observation— 9-3-54.

Treatments	Red spider population
Aramite plus Colloidal sulphur (1 lb. + 2/5th quart in 50 gallons of water)	17
Check.	1002

3. Date of application—16-3-54.

Date of observation—19-3-54.

Treatments	Red spider	
	Living	Killed
Aramite 1 lb. plus Thiovit 2½ lbs. in 50 gallons of water.	25	1048
Chlorocide W. P. 1 lb. plus Thiovit 2 lbs. in 40 gallons of water.	73	573
Check.	1028	1

From the results of laboratory and field trials carried out in 1954, Aramite appears to give effective control of Red spider but two applications may be necessary particularly during the rains. Aramite with Colloidal or Wettable sulphur undoubtedly gives better control than Aramite alone in one application.

Aramite does not taint the made tea but two proprietary preparations of wettable sulphur available in the market badly taint it whereas *only a suspicion of taint* could be detected with Colloidal sulphur. There is however little difference in valuation between the teas from Colloidal sulphur and check plots for two rounds of plucking following treatment. Whether this suspicion of taint disappears as the tea matures is a point which will receive our attention.

G.24353 (Chlorobenzilate) seems to give promising results against Red spider but further field trials are needed before it can be recommended. It has already been mentioned that this acaricide also does not taint the made tea.

Identification*

A. **Mites.**

1. *White Tea Mite*—A mite, similar to Pink mite in general appearance but differing from it by the presence of a white waxy covering over the major part of the body, has been recorded for the first time as attacking mature leaves, specially at the lower part of tea bushes. This is a new species belonging to the genus *Acaphylla* and will be described by Mr. H. H. Keifer, Systematic Entomologist, Bureau of Entomology, United States Department of Agriculture in due course.

2. *Pink Mite*—This mite which is known as *Calacarus theae* Watt., has been provisionally identified as *Acaphylla steinwedeni* K. by Mr. Keifer. It has not yet been definitely established whether the specific name *steinwedeni* should stand over *theae*.

3. *Calcarus carinatus* Green (Purple mite)

4. *Phytoptipalpus* sp. (Orange mite) attacking *Albizzia procera*

B. Isoptera-Termitidae

5. *Odontotermes assamensis* Holm. (Mound-building termite)

6. *Odontotermes parvidens* Holm.
7. *Odontoterms* sp.
8. *Microtermes* sp.

} Scavenger termites

9. *Microcerotermes* sp.—attacking living wood of tea bushes

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*Most of the determinations were made by the Commonwealth Institute of Entomology, London.

C. Hemiptera-Coccidae

10. *Lecanium* sp.
11. *Lecanium discrepans* Green
12. *Lindingaspis* sp. nr *ferrisi* Mek.
13. *Pinnaspis excercitata* Green.
14. *Nipaecoccus vastator* Mask.
15. *Coccus hesperidum* L.
16. *Farinococcus* sp.
17. *Coccus formicarii* Green.
18. *Saissetia nigra* Nietn.
19. *Phenacaspis manni* Green.

D. Hymenoptera-Formicidae—Ants found in association with Coccids and Aphis.

20. *Polyrhachis (Myrmhopla) affinis* Sm.
21. *Technomyrmex detorquens* Walk.
22. *Technomyrmex modiglianii* Em.SSp. *elatior* Forel.
23. *Crematogaster (Acrocoelia) dohrni* Mayr.
24. *Crematogaster (Acrocoelia)* sp.
25. *Pheidole sulcaticeps* Roger var *punensis* For
26. *Meranoplus* sp.
27. *Paratrechina* sp.

Advisory—123 specimens of insect pests were examined and reported on.

301 letters and memoranda were issued in connection with pests of tea and ancillary crops.

41 samples of insecticides were received for test.

Publications—The following Tea Encylopaedia Serials were published during the year.

1. Green Caterpillar—Defoliating Nursery and young shade plants. (Serial No. 103, filed under J.3.)

2. Pink and Purple Mites (Serial No. 104, filed under J.3., and Newsletter, Vol. I, No. 1).

3. Ant nests on tea bushes (Newsletter, Vol. I, No. 2).

4. 'Sewing blight' (Newsletter, Vol. I, No. 3).

Touring—The Entomologist visited Cachar, Golaghat, Sonari, Darrang and Darjeeling districts and a number of local gardens during the year. Two assistants visited Cachar and Darrang districts to conduct Red spider and Termite control trials.

MYCOLOGICAL BRANCH.

K. C. Sarmah—Mycologist

Bacteriology.—Weekly bacteriological tests of the Tocklai water supply were carriedout as usual throughout the year. The results obtained in each month are given below.

Months	Untreated water		Treated water		Remarks
	Total bacteria per c. c.	Lactose fermenters per c. c.	Total bacteria per c.c.	Lactose fermenters per c.c.	
January	19	14	2	0	
February	15	7	0	0	
March	84	54	1	0	
April (1st to 26th)	89	75	0	0	
April 27th to May 14th	230	230	57	42	The silver sterilising apparatus was under going readjustment from 27th April to 14th May. The treated water has been free from contamination since 15th May.
May (15th to 31st)	86	50	0	0	
June	38	19	1	0	
July	19	5	1	0	
August	32	4	0	0	
September	65	16	0	0	
October	32	14	0	0	
November	43	7	1	0	
December	25	5	1	0	

16 samples of water received from outside estates were tested for bacterial contamination.

Mycology

Blister blight.—The number of estates which reported the occurrence of the disease is shown month by month in the following table.

Months	Assam	Cachar	W. Bengal
January	...	1	...
February	1	...	1
March	4	...	2
April	8	...	1
May	1	...	...
June to October	No Blister blight reported		
November	3	...	1
December	2	...	...

In Upper Assam moderate to severe outbreaks of the disease during March-April and again in the early winter were preceded by a period of continuous cool and wet weather. Spring infection disappeared completely by the end of May.

Black rot—Winter spraying treatments at Meleng Tea Estate.—Spraying experiments were carried out during January-February to test the effect of mercury fungicides on the control of Black rot (*Corticium theae*). Two fungicides, oil soluble mercury compounds 580 and 618 supplied by Messrs. Murphy Chemical Co., Ltd., England, were applied at two concentrations to plots of 25 bushes with 5 replicates, i.e., 125 bushes. Two applications were made with low volume sprayers at an interval of 2 weeks. The treatments were as follows.

A. Compound 580 @ 1 pint in 15 gallons (recommended strength).
B. ,, 618 @ 1½ Pints ,, ,, ,, ,,
C. ,, 580 @ 1½ ,, ,, ,, ,, ,,
D. ,, 618 @ 2¼ ,, ,, ,, ,, ,,
E. Control.

The experiment was duplicated as the first application was followed by rain within an hour.

Monthly observations on the incidence of the disease during the growing season gave the following results.

Treatments	Average degree of infection	
	Experiment 1	Experiment 2
A	31·2	28·5
B	33·7	32·8
C	38·2	33·3
D	30·7	34·2
E	31·1	31·1

None of the treatments was effective when applied during the winter season.

Prophylactic treatment at Meleng Tea Estate

Spraying treatments were applied agsinst Black rot (*Corticium theae*) during the spring, once in the third week of April and again in the first week of May (at an interval of 2 weeks) using 11 fungicides at 0·25-0·5% concentration. One lot was used with a spreader, Agral L N @ 5 ozs. per 100 gallons.

There were 2 lots of 25 bushes each under each treatment. Low volume nozzles were used for spraying.

Monthly observations, on the incidence of the disease, from June to August gave the following results.

Treatments	Average degree of infection.		
	Before treatment	After treatment	
		Without spreader	With spreader
1. Coxycide 0·25%	32·7	26·6	38·0
2. Combacide 0·25%	37·7	14·3	34·0
3. Dithane 0·25%	25·0	40·0	19·0
4. Cuprox 0·25%	33·3	24·0	23·0
5. Cuprokylt 0·25%	34·0	40·0	32·6
6. Yellow cuprocide 0·25%	35·5	18·0	20·3
7. Shell-copper 0·25%	34·5	24·0	18·0
8. Crag 0·3%	30·5	35·5	15·3
9. Coppesan (modified) 0·25%	28·0	23·0	15·0
10. Cupromox 0·25%	33·5	32·0	22·0
11. Cupravit 0·5%	30·2	28·0	19·6
12. Control	24·0	36·0	36·0

Treatments 2, 4, 6. 7 and 9 without spreader and 3, 4, 6, 7, 8. 9, 10 and 11 with spreader gave appreciable reduction. Treatment Nos. 8 and 11 were used at 0·3% and 0·5% respectively, these being the recommended concentrations.

Red rust (Cephaleuros parasiticus).—A mercurial copper fungicide was received for trial in the last week of May. Although the time for prophylactic spraying was nearly over an opportunity of testing its effect on Red rust fructifications, wnich had already appeared, was availed on a young tea area at Gatonga Estate.

An area of 400 bushes was divided into 4 plots of 100 bushes each. Treatments were applied in the following way.

Plot 1 was left unsprayed.

,, 2 was sprayed with 0·25% Perenox.

,, 3 was sprayed with Mercurised copper oxychloride at 1 oz. per 2 gallons (recommended strength).

,, 4 was sprayed with Mercurised copper oxychloride at 2 ozs. per 2 gallons (double the recommended strength).

Two applications were made at an interval of 16 days, on 28. 5. 54 and 14. 6. 54. The leaf from the sprayed area was not used for manufacturing for 2 months after spraying.

Observations on the incidence of the disease on individual bushes in the above plots were made on 5. 7. 54. The intensity was recorded In the following way.

0—No Red rust fructifications.

1—Slight Red rust fructifications.

2—Moderate ,, ,,

3—Severe ,, ,,

Treatments.	Degree of infection	Degree of infection taking control as 100
1. Control	64	100
2. Perenox 0.25%	43	67·2
3. Mercurised copper oxychloride 1 oz. per 2 gallons	43	67·2
4. Mercurised copper oxychloride 2 ozs. per 2 gallons	27	42·2

The above results cannot be regarded as conclusive since it was not a properly designed experiment but the mercurised

copper oxychloride at the recommended strength seems to be equal in fungicidal value with 0.25% Perenox.

I wish to express my thanks to the management of the estates concerned for providing us with the facilities for carrying out the field trials mentioned above.

Nectria sp.—Experiment at Tocklai.—An inoculation experiment at Tocklai was started in November 1952 with Nectria sp. (Tippuk strain) to ascertain its pathogenicity.

An area of mature tea in plucking was selected for the purpose. 4 bushes were pruned at 22′ in the middle of each month commencing from November 1952. Six cuts on one half of each bush were inoculated with pure cultures, (containing macroconidia and mycelium) made from the perfect stage of the fungus, immediately after pruning, (i.e., within an hour) and wrapped with alkathene paper. Branches on different aspects of the bushes (north, south, east and west) were inoculated. Similarly 6 uninoculated cuts on the other half of each bush were wrapped with alkathene paper at the same time. These were used as controls.

The initial reserve content (starch) in the roots of each bush was estimated by the iodine method just before pruning.

Observations on the change of growth, amount of die-back, development of fructifications of the fungus etc., were made every month. The total length of obvious die-back of all the branches was measured in August 1954, i.e., 10 months after the last lot was inoculated.

It was noticed that the perithecial fructifications on inoculated branches developed after about 5 months from the time of inoculation; only in one case they appeared as early as two months. There was no fresh development of fructifications after 9 months. Under Tocklai conditions the fungus did not produce any fructification during the winter months of December-March.

The following table shows the results of the different observations.

TABLE I.

Time of inoculation	Initial reserves Av. of 4 bushes	No. of branches (out of 24 showing red perithecia		Die-back in inches (average of 24 branches)			No. of branches (out of 24) showing good growth in 1954	
		Inoculated	Control	Inoculated	Control	Difference apparently due to Nectria infection	Inoculated	Control
Nov. 52.	0	8	Nil	7·0	4·0	3·0	5	12
Dec. 52.	0	3	,,	4·2	2·5	1·7	15	15
Jan. 53.	20	21	,,	10·4	4·9	5·5	3	17
Feb. 53.	10	19	6*	15·0	12·7	2·3	0	4
Mar. 53.	25	11	6*	14·3	10·2	4·1	7	7
Apr. 53.	25	11	Nil	7·7	4·2	3·5	1	2
May 53.	10	6	,,	10·7	6·7	4·0	4	4
Jun. 53.	10	1	,,	8·0	7·3	0·7	5	3
Jul. 53.	10	0	,,	8·6	5·0	3·6	2	3
Aug. 53.	10	12	,,	9·3	5·6	3·7	3	2
Sep. 53.	50	3	,,	5·6	4·0	1·6	6	3
Oct. 53.	10	1	,,	6·2	2·1	4·1	8	7

(* On one bush in each case. There were too many ants on these two bushes and infection to the uninoculated cuts was probably spread by them).

The number of branches showing fructifications was very high in the January and February pruned lots. The extent of die-back was very high in February and March lots and it was lowest in the December pruned one.

The period January to April appears to be the most dangerous time in which to medium prune or to make any cuts into heavy wood in **Nectria** susceptible areas. April-May is the usual danger period for hail damage. Tea subjected to such damage in this danger period should receive prompt attention as per Tea Encyclopaedia Serial No. 65/1, filed under I·3.

The optimum time for medium pruning from the figures in the above table appears to be the months of October and December.

By grouping the above figures into quarterly periods, based on the usual pruning period of October—December, in most gardens we get the following.

TABLE II.

Time of inoculation following pruning.	Initial reserves (average).	Average No. of branches showing fructifications.		Average die-back in inches.			Average No. of branches showing good growth.	
		Inoculated.	Control.	Inoculated.	Control.	Difference apparently due to *Nectria* infection.	Inoculated.	Control.
Jan.-March	20	17	4	13·2	9·3	3·9	3·3	9·3
April-June.	15	6	Nil	8·8	6·1	2·7	3·3	3·0
July-Sept.	25	5	,,	7·8	4·9	2·9	3·6	2·6
Oct.-Dec.	0	4	,,	5·8	2·9	2·9	9·3	11·3

All the bushes under experiment were deficient in reserves. There was an appreciable amount of die-back, even on the uninoculated branches, which can only be attributed to the weak condition of the bushes. However a difference varying from 2.7—3.9 inches was maintained throughout the whole year between the inoculated and the uninoculated lots. It would therefore appear that an average of about 3" of die-back has resulted from the pathogenic action of the fungus.

Earlier field observations made (in 1952 by the Senior Advisory Officer for Assam Valley and North Bank and the Mycologist) at Tippuk Tea Estate showed that bushes having high starch reserves in the roots failed to take infection. Examination of the experimental plots at Tippuk made jointly by the Scientific Officer of Jokai (Assam) Tea Co., Ltd., the Senior Advisory Officer and the Mycologist, Tocklai, again in July 1953 showed that infection by Tippuk *Nectria* varied according to the initial reserves in the roots of the bushes concerned. There were more infected cuts on bushes which contained low reserves in their roots. Bushes which contained fair to good starch reserves at the time of inoculation either had no infection on their cuts or where some of them had been infected, the disease did not extend very far. Weak bushes were more suspectible to infection.

In this garden the tea outside the experimental area but adjacent to it carried a moderate to heavy infection of *Nectria* about 2 years ago. This tea was at the time of examination, making vigorous growth and most of the disease was disappearing as a result of modified cultural operations.

The foregoing observations suggest that *Nectria* sp., prevalent at Tippuk Tea Estate (producing macroconidia provisionally named as Cylindrocarpon sp., by the Commonwealth Mycological Institute and/a red perithecial stage of fructifications) is a pathogenic strain but it is a disease of weak bushes. For further confirmation of this important point the experiment in the above garden is being continued under the supervision of the Scientific Officer of Jokai (Assam) Tea Co., Ltd.

Another interesting point has emerged from the above observations. There seems to be a distinct relation between the time of pruning and amount of die-back, also between the former and the incidence of the disease (as judged by the branches

bearing obvious symptoms i.e., fructifications). The period between October and December, which is the usual pruning time in the gardens shows the least amount of incidence of the disease and die-back of the stems although the bushes were initially devoid of starch in the roots and the fungus had a longer time for its action than the rest. December however stands out to be the best within this period, taking all things into consideration.

Effect of desiccation and seed dressings on germination of tea seeds and the resulting plants.—In the past samples of young nursery seedlings with cork-screw formation on the root and/or shoot adjoining the cotyledons were received on rare occasions. In one of the Dooars gardens such a condition was observed once in 1949 and again in 1953 and 1954. Microscopic examination of the affected seedlings failed to reveal any infection by micro-organisms. In 1949 this phenomenon occurred in a nursery sown with 63% good seeds. The cause of cork-screw formation was then atributed to the drying and shrinking of the kernel inside the shell before germination.

In another Dooars garden in 1952 a number of crooked-stem seedlings were observed in a nursery where it was sown with rejected floater seeds (probably desiccated).

An experiment was therefore carried out at Borbhetta to test the effect of desiccation of tea seeds before planting. Opportunity was also availed, at the same time, to try out the effect of 2 mercurial seed dressings viz., Agrosan GN and Tillex, on germination and the resulting seedlings. The former was supplied by Messrs. Imperial Chemical Industries (India) Ltd., and the latter by Messrs. Atlas Fertilisers Ltd.

Seeds were obtained from the Tingamira Tea Seed Co., Ltd., Immediately on their arrival 3 lots of 2480 sinker seeds were treated in the following way, on 4.11.53.

* (1) 2480 seeds with Agrosan GN @ 300 gms. per 100 klgs.

(2) ,, ,, ,, Tillex ,, ,, ,,

(3) ,, ,, untreated

*(The seeds and the disinfectants were put in a drum and rolled lightly until the seeds were properly coated)

The above 3 lots were divided into 2 halves after treatment.

(a) One half (i.e., 1240 seed) from each lot was packed in 4 wooden boxes of 310 each using charcoal powder containing 41% moisture as packing material.

(b) The other half (120 seeds) was packed similarly without any packing material.

The boxes were then placed in the laboratory in a dry place.

Each month commencing from 11th November 1953 to 11th February 1954, one box of each treatment (a) and (b) was sown in 3 randomised beds of 100 seeds.

The beds were under bamboo lath shade; they were watered at intervals during the dry period.

A preliminary count of the emerged seedlings was made on the 10th of February. Results are shown in table III.

The seedlings were dug up between 3rd and 25th July 1954 and examined with the following results (tables I and II).

Seedlings with cork-screw formation (having one or more complete loops) of the stem and/or root adjoining the cotyledons were only marked as twisted. Those with a small bend due to the eye falling on the side were regarded as sound.

TABLE I — **Total Plants Emerged out of 300 Seeds (Sinkers) in each case**

Treatments	November 11th 1953			December 11th 1953			January 11th 1954			February 11th 1954			Total plants emerged out of 1200 seeds
	Plants emerged	Plants twisted	Plants sound	Plants emerged	Plants twisted	Plants sound	Plants emerged	Plants twisted	Plants sound	Plants emerged	Plants twisted	Plants sound	
Agrosan+packing ...	264	32	232	206	46	160	183	27	156	92	14	78	745
Tillex+packing ...	209	22	187	255	40	215	102	24	78	58	8	50	624
Control+packing ...	215	40	175	228	26	202	203	37	166	9	0	9	655
Total	688	94	594	689	112	577	488	88	400	159	22	137	
		13·6%			16·2%			18·0%			13·9%		
Agrosan – packing ...	221	27	194	160	37	123	58	11	47	—	—	—	439
Tillex – packing ...	222	37	185	191	59	132	—	—	—	—	—	—	413
Control – packing ...	245	25	220	171	45	126	61	18	43	—	—	—	477
Total	688	89	599	522	141	481	119	29	90	—	—	—	
		13·0%			27·0%			25·2%					

TABLE II

Months	Total Plants out of 600				Average Wt. per Plant in Gms.				Average Height per Plant in Inches			
	Agrosan	Tillex	Av. of treated	Un-treated	Agrosan	Tillex	Av. of treated	Un-treated	Agrosan	Tillex	Av. of treated	Un-treated
November ...	485	431	458	460	3·7	3·8	3·75	3·6	9·5	9·5	9·5	10·5
December ...	366	446	406	399	4·4	4·1	4·25	3·5	9·4	9·4	9·4	9·4
January ...	241	102	171	264	3·6	3·3	3·45	3·8	8·1	8·4	8·25	7·3
February ...	92	58	75	9	4·0	3·0	3·5	3·2	7·5	6·8	7·15	7·2

Number of plants emerged on 10th February.

TABLE III

Plots sown in	With packing material			Without packing material			Combined		
	Agrosan	Tillex	Control	Agrosan	Tillex	Control	Agrosan	Tillex	Control
November	71	29	23	24	36	34	95	65	57
December	5	7	0	0	0	0	5	7	0
January	...	...	...	...	...	...	...	...	...
Total	76	36	23	24	36	34	100	72	57

The above figures although not statistically significant suggest that :

(1) The initial percentage of twisting in November increased from 13.6% by about 2.6% in December and 4.4% in January in the seeds preserved with packing material while there was a sharp increase from 13% to 27% and 25.2% respectively in case of seeds preserved without packing material.

(2) The slight reduction in the percentage of twisted plants (1.8%) when sowing of the seeds preserved without packing material was delayed until January was apparently due to the heavy reduction in the numbers of total germination.

(3) Increase in percentage of twisted seedlings can be effected by desiccation of seeds before germination. This twisting will probably increase further in soils having less moisture retaining capacity than that of the Borbhetta soil where the experiment was conducted.

(4) The seed preserved under laboratory conditions without using any packing material lost its viability completely after two months.

(5) There is no appreciable difference in the total germination of seeds between the treated and the untreated if both the seed dressings are taken together. Agrosan GN. however gave 6.1% and 2.2% higher germination than Tillex and untreated respectively.

(6) Seed preserved in packing material for 14 weeks retained its viability in 30.6% when treated with Agrosan GN against 19.3% with Tillex and 3.0% untreated.

(7) Seed preserved without packing material for 9 weeks lost its viability completely when treated with Tillex against 19·3% and 20·3% with Agrosan GN and untreated respectively.

(8) There was no effect of seed dressings on the growth of the plants subsequent to germination.

(9) Agrosan GN hastened germination to an appreciable extent in the beginning.

Eelworms-Effect of soil fumigants.—An experiment was carried out at Tocklai to test the effect of soil fumigation with Shell D-D and Methyl Bromide.

20 plots of 4′ × 9′ each were prepared in an area known to be infested with eelworms. They were also inoculated on 7.10.53 with a large number of eelworms bred in the laboratory on decomposed tea seed. Eelworm counts were made 15 days after inoculation. 4 treatments were applied to 5 randomised plots in the last week of October 1953. The treatments were as follows.

1. Shell D-D-2 c.c. injected into the soil at 6′ from the surface 1 ft. apart with a soil injector (at the rate of about 200 lbs. per acre).

2. Shell D-D—4 c.c. applied as above (at the rate of about 400 lbs. per acre).

3. Methyl Bromide—3 ampoules of 20 c.c. each broken at 6'' below the surface (rate of application per acre is 300 lbs.)

4. Control.

Eelworm counts in the soil were made again after 1 month of application.

100 pregerminated seeds were sown in each bed 6 weeks after treatment (middle of December.)

The beds were unshaded; they were watered at frequent intervals with tap water and hand weeded from time to time.

Seedlings were dug up without damaging the roots as far as possible and examined for eelworm infestation in the second week of July 1954.

Intensity of infestation was recorded as follows.

0 for unaffected plants.

1 for slightly affected plants.

2 for moderately affected plants.

3 for severely affected plants.

Eelworm population in the beds was also estimated after the plants were dug up.

The results are tabulated below.

TABLE I

	Eelworm population per 10 gms. of soil (average of 5 plots).			Treatments.
	15 days after inoculation but prior to fumigation.	1 month after fumigation.	9 months after fumigation.	
1	26	2	1	Shell D-D 200 lbs.
2	25	2	1	do 400 ,,
3	40	6	2	Methyl Bromide 300 lbs.
4	27	23	6	Control.

TABLE II

Effect of treatments.

Treatments.	Total seeds sown.	Total plants obtained.	Average weight per plant in gms.	Average height of plant in inches	Total plants			Degree of infection per 100 plants
					Affected		Unaffected	
					Light	Moderate to severe		
1	500	386	15·5	17·8	191	64	131	88·0
2	500	367	13·5	17·4	148	88	131	98·3
3	500	344	11·8	16·1	129	67	148	86·3
4	500	361	12·7	15·3	179	111	71	126·3

The above figures indicate that after deducting the moderately and severely affected plants the total numbers likely to outgrow the attack are as follows.

TABLE III

Treatments	Plants likely to outgrow attack		Plants condemned	
	Total	%	Total	%
1	322	83·4	64	16·6
2	279	76·0	88	24·0
3	277	80·5	67	19·5
4	250	69·2	111	30·8

The results are not so satisfactory but there is a trend in favour of the overall effect of Shell D-D fumigation, the plants being larger and heavier. Methyl Bromide also reduces eelworm infestation but it appears to retard the growth of the plants to some extent.

Further trials will be undertaken.

Advisory.—445 specimens of fungus diseases were examined and reported on. 162 samples of soil from proposed nursery sites were received from outside estates and tested for Eelworm infestation.

352 letters and memoranda were issued in connection with diseases.

6 samples of fungicides were received for trial.

Publication—The following Tea Encyclopaedia Serials were published.

1. Blister blight (revised) Serial No. 62/1, filed under I.3., with an appendix on spraying technique by the Senior Advisory Officer, Assam Valley & North Bank.

2. Brown and Grey blights (revised) Serial No. 63/1, filed filed under I·3.

3. "Damping off" disease of young tea seedling—Serial No. 101, filed under I·3

4. Weak condition of young tea due to defective planting in heavy soils—"TWO AND A BUD" Vol. I. No. 2.

Touring.—The Mycologist visited 6 local gardens.

ENGINEERING DEPARTMENT.

I. McTear Resident Engineer.

During the course of the year Pilot Factory construction was begun in February and was completed in the the month of August. The building is equipped with necessary electrical power circuits.

Under the heading of development work Controlled Withering and the Continuous Tea Roller have been investigated. Controlled Withering has necessitated a considerable number of experiments in the Experimental Withering Chamber so that a suiable optimum could be decided upon. With so many variables in the process of withering tea leaf each aspect has to be considerad in relation to its application on a commercial scale. For instance leaf spread at the conventional rate of one pound per square yard would not result in adequate reduction in size of the instullation when compared with existing arrangements. Since supplementary heat must be used throughout most if not all of the season radiating surfaces must be reduced to a minimum if economy of operation is to be achieved. It is quite obvious that in order to make a withering unit compact the first approach to the subject was density of spreading of the leaf. In order to arrive at a satisfactory rate of spread the final outcome of 3½ Lbs per square yard was approached by stepping-up the rate of spreading in successive experiments and analysing the results. All things considered this rate of spreading of leaf has proved to be a very practical proposition and in conjunction with close spacing of withering trays in which provision is made for spreading and discharge of leaf unimpeded by any from of structure a very compact unit results. The chamber measurements are 27′-0″ x 18′-0″ x 6′-0″ in which is accommodated 6000 Lbs of leaf.

The rate at which air loses its drying properties when traversing leaf spread as already mentioned has also been the subject of close study resulting in air travel being fixed at 18 feet thence exhausted to atmosphere.

When controlled withering is applied to tea leaf a further problem arises necessitating the reversal of exactly similar con-

ditions of airflow and temperature in order to obtain uniformity of evaporation. There are several ways of achieving these conditions. Each in turn has been closely examined from a practical angle until finally what perhaps is best described as a "Two-stage Controlled Withering Tunnel" has been evolved in which half the process is obtained in one Tunnel and the balance in an opposing tunnel. This arrangement dispenses with doors and reversing valves and additionally such fans that are installed are in operation while ever the plant is in commission. In other words the necessity for reversing or pivoting fans is eliminated.

The scheme can be arranged for ground floor operation or in an upper floor of a Factory with equal facility.

The withering process can be achieved in approximately 4 hours so making it possible to use the same spreading area several times over during the course of a day.

A considerable number of experiments has been conducted during the past season in an endeavour to evolve a satisfactory action for the Continuous Roller the prototype of which was constructed at Tocklai. The latter stages of experimentation gave promise of better results and in competition with teas manufactured by the conventional two rolls of 25 minutes each the teas from the continuous roller were preferred by tasters.

A machine having an out-turn of approximately 400 Lbs per hour in one operation is now being made by a Calcutta firm who have promised delivery in the early part of the approaching season. The machine will be put into commission as soon as to hand so permitting tests on a commercial scale to be undertaken.

The mechanically operated tea harvesting machine arrived on site towards the close of the cropping season when a preliminary test was conducted at Borbhetta. Due to certain unsatisfactory aspects the test could not provide much useful information until the defects had been remedied. These, in the main, concerned the ground speed of the machine which, in bottom gear (4 forward speeds) was considered to be somewhat excessive. Likewise the speed of the cutting mechanism called for

certain reductions as well as removal from its central location, where interference with harvested leaf caused leaf to be thrown back on the bushes, to side mounting, providing better accessibility and a more satisfactory drive arrangement.

The Berk Ring Dryer was subjected to preliminary tests but rather excessive short-circuting of improperly dried tea curtailed further tests until certain alterations could be effected.

The electric heater elements were found to radiate a considerable amount of energy resulting in excessive heat losses. This has been effectively cured resulting in an additional 50°F being available within the ring circuit. The equipment is now ready for experimental work and the upper limit of temperature available is 330°F.

Advisory Branch : Assam Valley

Staff.—Senior Advisory Officer, Assam—P. M. Glover. M.B.E. B.Sc.

Advisory Officer, Cachar—E. D. Heath B.Sc.

Mr. E. D. Heath continued his training at Tocklai, until 23rd June when the Agriculturist went on leave. During the Agriculturist's absence in the U. K., Mr. Heath acted for him; on the former's return Mr. Heath went to Cachar where he opened the Advisory Branch Surma Valley on 13th December at Silcoorie T. E. Silcuri P. O.

The Senior Advisory Officer, Assam underwent a major operation in the Mission Hospital Jorhat on 18th January 1954. He was unable to carry out touring duties until towards the end of February. On the 28th March 1954, he proceeded on home leave returning to duty at Tocklai on 8th October 1954.

Touring and Meetings.—As explained above touring was considerably restricted on account of illness and U. K. leave.

Visits were paid to the following gardens :

Assam Valley

Jorhat Circle	...	15 gardens
Golaghat Circle	...	10 gardens
Nazira Circle	...	1 garden
Tingri Circle	...	2 gardens
Moran Circle	...	1 garden
Sonari Circle	...	2 gardens

North Bank

Bishnath Circle	...	2 gardens
Borsola Circle	...	1 gardens

The Senior Advisory Officer, Assam, attended the Annual General Meeting of the Assam Valley Branch Indian Tea Association held at Jorhat on 19th and 20th November, 1954.

Lectures.—The Tocklai Annual Lecture Courses were held between February 22nd and March 6th. On each course the Senior Advisory Officer, Assam lectured on "Principles of Pest and Disease Control Measures on Tea Estates", and on one Course on "Pruning" in the absence of the Senior Advisory Officer, West Bengal.

Encyclopaedia and Publications.—The following Tea Encylopaedia Serials were issued :

Appendix to Serial 62/1	...	Spraying Technique against Blister Blight
Serial 33/2	...	Recipes for pesticides which can be prepared on the garden (revised)
Serial 82/1	...	Notes on Bamboos with Senior Advisory Officer, West Bengal.

An article on "Mechanisation in the Tea Industry in Northern India" was published in World Crops Vol. 6 No. 5 1954, by the Director and Senior Advisory Officer, Assam.

Multi Level N. P. K. Experiment Panitola T. E.—This experiment, which is identical with that at Borbhetta, is being conducted at Panitola T. E. with the co-operation of the Scientific Officer, Jokai (Assam) Tea Company (vide Annual Report for 1953).

In the first year the gross effect of nitrogen was highly significant over no nitrogen. 80 lbs. N per acre gave a yield significantly greater than 40 lbs. N per acre (5% level). P and K have had no effect as also NP,NK and NPK.

Fertilisers were however applied too late to obtain the full effect in that current season.

Multi Level N. P. K. Experiments.—Two new N. P. K. experiments identical with those at Panitola T. E. and Borbhetta (vide Annual Report for 1953) which involve 34 different treatment combinations have been laid down at Borjuli Tezpur Circle North

Bank and at Sockieting T. E. in the Golaghat Circle. Preliminary yields have been taken this year, and manurial treatments will be begun in 1955.

The results of these experiments will be of considerable value to gardens in the Darrang district and Golaghat Circle which have similar soils, and will fill in gaps in our knowledge when taken in conjunction with the results of similar experiments in other districts.

N. P. K. Experiment Tezpore and Gogra.—In view of the newly laid out Multi level N. P. K. experiments at Borbhetta, Panitola, Sockieting and Borjuli T. Es, the single level N. P. K. experiment at Tezpore Gogra has been terminated.

Our thanks are due to the Manager, and his staff for their co-operation in running this experiment for us, the results from which have been most valuable.

Inorganic and Organic fertilisers.—(*a*) ***Halem T. E.***—This experiment is now in its twenty third year. As in 1953, the yield from an inorganic fertiliser (ratio N 40 P 20 K 20) and an organic manure (200 mds. cattle manure) per acre were significantly (5%) greater than from the check. The yield from the inorganic fertiliser was just not significantly greater than that from cattle manure, at these rates.

(*b*) ***Jamirah T. E.***—This experiment is now in its seventh year. As in 1955 80 lbs. N. per acre as sulphate of ammonia, or as oilcake, gave yields significantly greater than from the unmanured plots. On this sandy soil there was no significant difference between the yields obtained from the inorganic and organic fertiliser.

Shade Nitrogen and Plucking.—This experiment at Hunwal T. E. is now in its eighth year. The tea is Betjan and the shade which has deteriorated rapidly recently is now very light indeed.

Nitrogen at 120 lbs. per acre gave an overall gain of 5 mds. per acre as compared with the yield from plots receiving only 40 lbs. N per acre. The gain from unshaded plots was 57 mds. and from shaded 4.3 mds.

The overall gain from shade against no shade was 2.9 mds. Difference in plucking level had no significant effect.

Figures significant at the % level.

Nanuring on Bheel soils.—An experiment is in progress at Sephinjuri Bheel T. E. Cachar conducted by the Scientific Offiicer, Jokai (Assam) Tea Company.

Results for 1953 showed a significant (5% level) increase from P_{40} K_{30}. No Potash plots are beginning to show up as inferior to the naked eye.

Yield figures for 1954 were received too late for inclusion in this year's Annual Report.

Manuring under shade:—Eight experiments are in Progress on gardens on the North Bank.

Now that the figures from the Agrotype survey in the Tezpur Circle are to hand a survey of these experiments will be made in respect of level of nitrogen, shade, and Agrotype index.

Spraying Machinery.—While on leave in the U. K. the Senior Advisory Officer, Assam designed a Tractor mounted spraying implement.

Briefly the machine consists in a 60 gallon spray tank designed for mounting on the hydraulic lift of a Ferguson or Fordson Tractor, in exactly the same way as any other tractor implement. Spray fluid is fed to booms or hoses by a gear pump driven from the power take off of the tractor. Pressures up to 160-186 lbs. per square inch can be obtained. Agitation of the spray fluid in the tank is provided, and the machine is self filling :

The machine has four main uses :

(a) Selective Weed Killer spraying in thatch baris and grazing land.

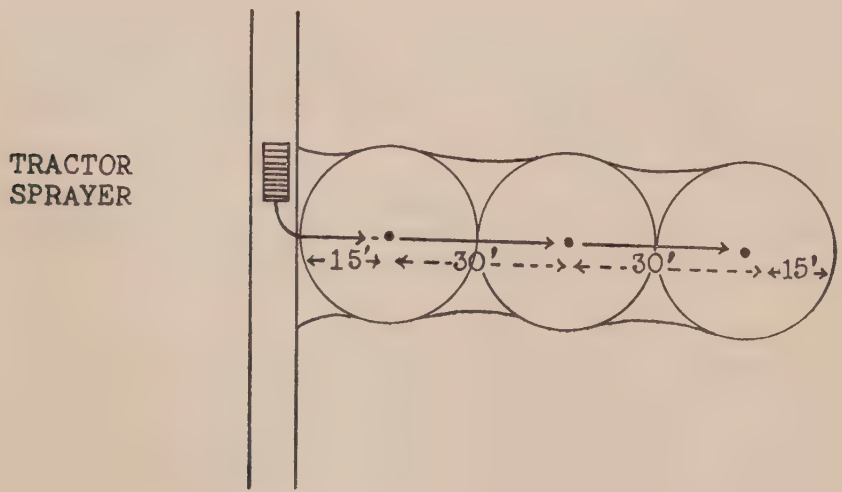
(b) Spraying of tea.

(c) Spraying of shade.

(d) As a Central Charge Pump for Knapsack sprayers.

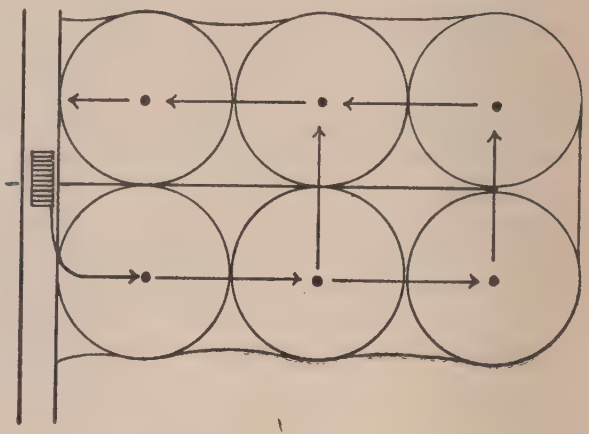
For spraying tea the booms are removed and the spray fluid is fed through hoses wound on drums on top of the spray tank and supported on adjustable arms, to specially designed trigger controlled spray lances.

Each operator moves into the tea a distance of 15' and from this position sprays a roughly circular area of 30' diameter, round him. On completion of this task, he moves outward a further 30' into the tea and sprays a second circle of diameter 30'. The operator can then move in still a further 30' and can spray a further circle of 30' radius. At this point the hoses are extended to 75' on either side of the sprayer and the area which has been covered is 75' long by 80' wide on either side of the road or roughly 1/8 of an acre (37 nuls). At full extent a second man (who need not be skilled) is required on each hose to hold it off the surface of the tea bushes. (Tripod man)



The operators next move forward 30' and the performance is repeated in reverse, moving back to the road. As the road is approached the centre or "Tripod" men reel in the hose on to the drums using the capstan-like spokes. An area of over ¼ of an

acre (64 nuls) has now been completed, and the tractor moves forward 60′ and the performance is repeated :



N. B. Diagrammatically the area sprayed from each stand is circular, in practice as the operator has considerable freedom of movement, and does not remain stationary at the centre cf each circle, dead areas between the circles do ***not*** occur.

For spraying shade a change of spray jet only is required and shade to 40′ high can be sprayed to a depth 75′, on either side of a road or path wide enough to take a tractor.

A spray team thus consists of a Tractor driver, two spraying men, and two "tripod" men, or a total of 5 men and should be able to cover not less than 1½ acres per man per 8 hour day as compared with ⅓rd of an acre per man per day with Battery equipment. It may be possible to improve on this technique. An advantage is flexibility, which allows of modification of technique according to the shade tree spacing.

For such areas as are beyond 90′ from a road capable of taking a Ferguson tractor the machine can be used as a mechanised charge pump to charge six Knapsack sprayers simultaneously. By a minor modification of the hose distal fitting, any make of Knapsack can be charged.

The machine can be fitted on to the Tractor in about 15 minutes. It is designed for Ferguson or Fordson tractors, but could be supplied to fit any make of Tractor fitted with hydraulic lift and power take off.

The cost is approximately Rs. 5000/- ex-down. For comparison a Battery Unit one Central Charge Pump and 12 sprayers is capable of a much smaller acerage in the same time and would cost about Rs. 4,700/- FOR/B Calcutta.

The tractor spraying unit should prove of considerable value also to Medical Officers in spraying line houses and in anti-malarial work in general. For this purpose a change of nozzle only would be required.

The machine is made by Messrs. Four Oaks.

WEST BENGAL ADVISORY BRANCH

Dooars

R. I. Macalpine Bsc. Senior Advisory Officer.

Touring.—(1) The Senior Advisory Officer made visits to Estates in the Dooars on 85 occasions during the year as follows :—

(1) Oodlabarie Sub-District ...
(2) Mal Sub-District ...
(3) Chalsa Sub-District ...
(4) Nagrakata Sub-District ...
(5) Binnaguri Sub-District ...
(6) Dalgaon Sub-District ...
(7) Kalchini Sub-District ...
(8) Jainti Sub-District ...

He also visited Estates in the Darjeeling District and 3 in the Terai.

(2) The following meetings were attended.

(a) Annual General Meeting of the Terai Planters' Association on the 20th January' 54.

(b) Annual General Meeting of the Darjeeling Branch I. T. A. on the 6th March '54.

(c) Annual General Meeting of the Dooars Branch I.T.A. on the 21st January, '54.

(d) Annual General Meeting of the Indian Tea Planters' Association on the 10th April '54.

(e) Annual Scientific Conference at Tocklai from 6th—8th Dec' 54.

(3) Talks and Discussions were held at Mal Club on two occasions and the Central Dooars Club on one occasion.

(4) The Advisory Officer visited Tocklai, apart from the Scientific Conference, for the General Courses from 19th to 5th March and on a liason visit from 18th to 24th August '54.

Experiments.—*(1) NPK Trial at Kalchini T. E*—An experimental plot was laid out in Kalchini T. E. to study the effect on yields of applications of N, P and K in various proportions.

The trial was initiated at the request of the Director Tocklai and is one of a series laid out in Assam, Dooars and Darjeeling

Plucking was commenced on 11th May, 1954 and plots were plucked regularly thereafter on a 7 day round.

The various manurial treatments were applied on 23rd July '54, yields up to that date being used for calculation of initial comparability.

The supervision of plucking and the measurement and recording of data was undertaken on each occasion by Mr. S. C. Dey, Field Assistant.

(2) *Vegetative propogation.*

Mention was made in the Annual Report for 1953 of the feature of excessive callus formation in inter-node cuttings in various localities in the District.

It was then considered that while water-logging was likely to be a contributory cause, other factors might be involved.

Soil was obtained from two different areas in the Dooars, namely Mal and Kachini and put down as cuttings beds at Headguarters together with Red Bank soil which occurs in the area.

The Mal soil was of the typical "Mal sand" type, of a light nature containing mica, the Kalchini soil being typical "grey silt". In each of the the three types of soil, half the beds were ridged, the other half being flat and of the usual cutting bed pattern.

In the former the ridges were some 3" high and 3" wide arranged so that one line of cuttings could be accommodated in each ridge.

The ridged beds were intended to reduce moisture content of the soil.

Cuttings obtained from a number of local bushes were put down commencing from 3rd May and continuing at approximately fortnightly intervals till the 15th July. A further series were laid from 7th September to 30th October '54.

In addition to the ridged and unridged beds, flat beds in Red Bank soil were protected from rainfall by placing Alkathene sheets over them (under bamboo lath frames) for comparison with unprotected beds.

Results at the end of the year were as follows :—

Ridged versus unridged beds.	(I) *Kalchini Soil* survivals—Ridged beds 12%	Unridged beds 27%
	(II) *Red Bank soil* ,, Ridged beds 21%	Unridged beds 38%
	(III) *Mal sand soil* ,, Ridged beds 29%	Unridged beds 34%
Covered beds versus Uncovered beds	(IV) *Red Bank Soil*—survivals Covered 52.5%	Uncovered 42 %

Excessive callus.

It was observed that there was tendency for a greater degree of excessive callus to form (a) in Kalchini soils than in either Red Bank or Mal sand soil, the latter being best in this respect (b) in covered beds of Red Bank soil than in uncovered (c) there was no appreciable difference between ridged and unridged beds in respect of excessive callus formation.

Time of taking cuttings.

Early season—Cuttings were put down on the following dates ; survivals are shown against each :—

8th May	...	12%
13th/15th May		18%
29th May	...	43%
12th June	...	34%
2nd July	...	38%
15th July	...	49%

It will be observed that a high increase in the survival rate occurred from 29th May onwards. This has also been the experience of Planters in practice in respect of the end of May period and it would appear that during 1954 at least, the setting of cuttings later than in normal practice would appear to have been beneficial. It should be noted however that the Dooars suffered from a particularly severe drought up to the end of May. It is possible that the retardation of growth which occurred as a result of this drought may have affected the position. Further trials will be necessary.

It should further be noted that the trials were initially intended to study excessive callus formation and cuttings were lifted in September for examination and then reset in the beds.

This no doubt accounts for the poor survival rate but the percentages shown in the above tables can be taken as comparative.

Autumn cuttings.

The following shows the position in respect of survival rates of Autumn cuttings as assessed on 10th December.

		Survival
7th/11th September	...	83%
15th/16th September	...	76%
21st/25th September	...	80%
19th October	...	83%

It is interesting to note that callus formation is light in all cases.

Twisted root in tea seedlings.—At the request of the Tea Pathologist trials were initiated to examine the effect of storage of tea seed on the degree of formation of twisted roots.

Seed was obtained from a local seed barie and divided into 5 lots. Treatments are as follows :—

One lot immediately sown on receipt of the seed (2nd December'54). Four lots were packed in moist charcoal to be sown on 15th December, 15th January, 15th February and 15th March.

In addition four lots of seed were treated with Tillex seed dressing and stored in tins without charcoal but buried underground, to be sown on 15th December, 15th January, 15th February and 15th March. All seeds are pre-germinated before sowing. A surprising feature of the lot packed in wet charcoal in a sealed tin on 2nd December and opened on 15th January was that 180 out of the total of 300 had germinated within the tin. In many cases radicles were 2 to 3 inches long.

Green crops : **(*a*) *Stylosanthes gracilis.***—Seed obtained from crops growing at this Headquarters and from a Dairy Farm in the Kalchini area were distributed to certain Estates for trial under field conditions with generally poor results when sown direct. Too much attention in respect of cleanings is required in its early stages to make it a suitable crop for direct sowing. At this Headquarters the original area has been very satisfactorily extended by dibbling in cuttings. Those put down during May-June have completely covered the area and at the end of the year were still green in spite of somewhat droughty conditions since the middle of October.

Cuttings put down at intervals thereafter to the end of September exhibit degrees of establishment in proportion to the lateness of setting. Those put down in September are in the main surviving but ground coverage is negligible.

Experience this season confirms the opinion expressed in last year'sAnnual Report that establishment of this species as a green crop in the field is likely to be best done by the employment of cuttings obtained from stock raised in multiplication areas raised from seed.

The original crop raised from seed sown in June 1953 was sickled down to ground level for seed collection in February, 1954. Complete regrowth has occured and the whole area is covered by the species.

While it does not completely suppress "Bagrakote jungle" (Borreria hispida) it replaces it to a considerable extent. It however suppresses Thatch (Imperata cylindricum syn arundinacea) completely.

(*b*) *Mimosa invisium* —This thornless sensitive plant was put down in an area at this Headquarters between lines of established Boga medeloa and in the open.

In the latter it flourished and formed a thick mat of vegetation over the ground but in the former tended to climb into the Boga and as such ground coverage and its suppressive power on weeds was considerably reduced.

By the end of the year most of the foliage had fallen and the crop cosisted of nothing but long stems carrying clusters of pods.

(c) *Priotropis cytisodies*.—More and more use is being made of this species as a cover crop in young tea and for green crop nursery shading in certain Estates.

It reacts favourably to lopping as is practised in the case of Boga medeloa and Crotalaria anagyroides but a feature of the species is its comparative greenness during the dry weather months in comparision with Boga medeloa and Crotalaria.

On ocular estimate it would appear to be a satisfactory alternative to Boga which in view of the widespread incidence of Red Rust in the Dooars must be held in disfavour.

Pathological.—(*i*) *Psyllid* (*Plant lice*).—Plant lice continued to cause devastation to nurseries of A.odoratissima, procera, and stipulata. The former is particularly susceptible and when heavily infested fails completely.

Results of control by spraying with insecticides were very variable from locality to locality. Where success has been attained spraying has been carried out at intervals of not more than seven days but even this has not been sufficient to prevent damage in other areas.

It is evident from the nature of the habit of the pest that for control foliage must be completely drenched and that for this purpose fine, low volume spraying equipment is essential as with large droplet size nozzles much of the spray fluid is not retained by the foliage and coverage is inefficient.

It is of interest to note that in certain Estates burning of a mass of jungle litter on the ground before preparation of nursery beds has resulted in complete success in the case of A. odoratissima without the necessity of spraying subsequently. This is forest practice and is worthy of trial in view of the difficulties now being experienced in the raising of shade tree seedlings.

(*ii*) *Defoliators*—Concomittant with damage by plant lice there is defoliation by larvae of Lepidopterous insects, chief amongst which is Rhesala moestalis.

Weekly spraying for Psyllids usually controls this pest but where nurseries are small in extent a practicable and efficient method of control is by physical destruction of the caterpillars by hand. The construction of webs under cover of which the larvae commit their depredations reduces the efficacy of insecticide considerably and physical destruction under such circumstances is of considerable value in their control.

(*iii*) *Buprestidae*—From several areas in the Eastern Dooars reports were received of damage to the stems of saplings of A. odoratissima and A. stipulata by bark borers. The Entomologist, Tocklai, identified the insects as Agrilus beesonii—a Buprestid. Symptoms of attack are the exudation of drops of a gummy resin from the bark. These exudations which seal the bore holes make

control by spraying or washing with insecticides ineffective but it may be possible to reduce the severity of an original attack by prophylatic treatment by such methods.

It is of interest to note that in a certain Estate one growing season old A. stipulata and A. odoratissia plants in the nursery were attacked by this pest generally at the collar region or immediately above.

(iv) Cephalerous parasitica (Red Rust)—Further observation during the year on incidence of Red Rust on shade tree species disclosed that in a number of cases infection commences in the nursery during the first seasons growth and plants thus go out into the field already infected. By virtue of the fact that at this stage of development seedlings are in the main single stemmed, and have not formed corky bark, further infection of the bole is probable and this may in part at least account for the poor development of young plants in the field after planting out.

Attention in the nursery stage has apparently become a necessity and precautions should therefore be taken to remove possible sources of infections eg. Boga medeloa or rejected plants from previous years sowings from the vicinity of shade tree nurseries. Prophylactic treatment with fungicides would probably also pay.

Red Rust continues to exhibit itself on mature shade trees, in particular A. stipulata, and the "stag headed" appearance of even comparatively young trees is largely attributable to Red Rust infection.

It is of interest to note that in a certain Estate last years treatment accorded to Red Rust attacked tea included the lopping off of dead branches of shade. Recovery of the crowns is complete and it will be interesting to see whether in the coming growing season Red Rust infection will again exhibit itself to the original extent.

Tea.—***(a) Red spider.***—(Metatetranycbus bioculatus).

Red spider was severe all over the District immediately the drought of the early part of the year broke, when the rapidity with which epidemic incidence was reached was a startling feature.

By November it was again beginning to show up in various localities and by the end of the year was again severe.

(*b*) *Thrips.*—An interesting feature of the early part of the growing season was the incidence of Thrips to quite a severe degree in certain parts of the Dooars. While this insect is known to exist in the area the damage normally caused is negligible. Presumably as a result of the retardation of growth brought on by the drought and as a corollary thereto the delay in establishing regular plucking rounds, Thrips were able to increase to a degree of epidemic incidence and in certain areas eg. Kalchini District immature shoots exhibited all the appearances of tea under Thrip attack in the Darjeeling District. With the advent of favourable growing conditions Thrips virtually disappeared.

(c) *Tea Mosquito*—(Helopeltis theivora)

Helopeltis theivora made its appearance as usual towards the beginning of June and again in October, when in certain localities it was severe enough to necessitate control operations being undertaken.

(*d*) *Comocritis pierii*—This bark eating caterpillar has achieved prominence in a certain Estate in the Central Dooars where its degree of incidence is abnormally high and damage to bark is appreciable.

Trials on control by the application of Dieldrin are contemplated as experience elsewhere has shown that treatments with B. H. C. or DDT preparations are relatively ineffective.

It should be noted that in most localities this pest occurs to a greater or less extent but in the Estate referred to it was surprisingly high.

(*e*) *Bardaessa omisa*—Damage to Derris robusta this year has apparently been confined to certain localities, those areas which during past years have sufferred almost regularly from two or even three defoliations in a season having virtually escaped this year. It is presumed that the abnormal climatic conditions which prevailed this year are responsible for the reduced degree of incidence of this pest.

Flood damage.—A number of Estates suffered to a greater or less extent from flooding.

Apart from the damage resulting from the actual inundation of tea areas by flood waters, considerable repercussions have arisen from the deposition of silt.

The first of these is that in all cases where silt has been chemically examined it has been found that pH values show them to be alkaline in nature. This presumably results from the fact that the rivers which have caused the flooding rise in regions where there are limestone deposits and the silt is derived from these rocks.

It remains to be seen whether this alkalinity will be reduced in the course of time by natural agencies.

The second noticeable effect of silting has been the death of many bushes from Sphaerostible repens (Violet Root Rot)

It is presumed that infection by this fungus is a secondary result of the silting and is related to disturbances of normal drainage, but in view of the general rise in the levels of river beds, and presumably as a corollary thereof of the permanent water tables, the future of areas of tea adjoining them will remain a matter for concern in the ensuing monsoon period.

In certain Estates tea bearing ground is actually below the level of the adjoining river beds. In one particular Estate water was found at 5' below ground level in the 3rd week of December.

The typical symptoms of the disease began to show up from 6 to 8 weeks after the recession of the flood water.

WEST BENGAL ADVISORY BRANCH

Darjeeling & Terai

A. D. Swan, B. Sc., Advisory Officer.

Administration.—The Advisory Officer proceeded on Home Leave on 12th November, 1964.

Touring & Meetings.—The Advisory Officer made 68 visits in the Darjeeling district and 7 visits to Gardens in the Terai District.

The Annual General Meeting of the Terai Planters' Association on the 20th January, 1954 and the Annual General Meeting of the Darjeeling Branch I. T. A. on 6th March, 1954 were attended.

The Advisory Officer visited Tocklai from 17th—24th February, 1954 and attended the first annual lecture course, and again visited Tocklai from 19th—34th August, 1954.

During the monsoon touring was some-what restricted due to land slides and the shortage of petrol.

Visitors.—Mr. S. K. Dutta visited this branch from 5th—8th March, 1954.

Mr. J. Cranham of Boots Pure Drug Co., visited Darjeeling from 15th—19th March, 1954 in connection with field trials against Red Spider, using Chlorparacide.

Messrs. D. J. Wood and J. M. Trinick visited this district from 16th—30th May, 1954.

Experiments : *Miniature Manufacture.*—In the early part of the year eight bushes were selected in Puttabong each showing marked colouration at the base of the leaf and in the petiole. As petiole pigmentation is common in this district only bushes showing this character to an outstanding degree were selected. It was intended to subject these bushes to individual manufacturing trials as it was thought that this petiole pigmentation might be to some extent indicative of "Darjeeling Flavour".

Transverse sections of the petioles of these and other bushes showing some petiole pigment showed that in the more marked examples the pigmentation shows up a definite pink ring just below the cambium layer. In the less marked examples pigmentation was more diffuse.

The eight bushes selected also had hair on the tip, but the hairiness of tip was much less than can often be found on non-pigmented bushes.

During the course of the season two of these bushes were very badly attacked by Blister Blight and it was not possible to manufacture leaf from them. Leaf from the remaining six bushes was manufactured on several occassions but of these only one was reported to have "some flavour."

It is hoped that it will be possible to select more bushes showing pigmentation and having some hair on the tip for further manufacturing trials.

A further 15 bushes which had been subjected to miniature manufacturing trials last year were again included in the programme this year. Of these eight were reported to have Darjeeling characteristics to some extent. Two of these also received similar reports last year.

Chlorparacide Trials.—In February and March four small trials were laid out using Boots Pure Drug Company's Chlorparacide against Red Spider, *Tetranychus bioculatus*. One of these trials was done under the supervision of the Entomologist from Boots' Nottingham laboratory. In three of these trials five treatments were applied viz.—

(1) 20% Chlorparacide dispersible powder at the rate of 1lb. per acre+Lime Sulphur at a dilution of 1 : 39.

(2) 20% Chlorparacide dispersible powder at the rate or $\frac{1}{2}$ lb. per acre

(3) 20% Chlorparacide dispersible powder at the rate or $\frac{1}{4}$ lb. per acre

(4) Lime Sulphur at a dilution of 1 : 39.

(5) Control

In the fourth trials there twere only four treatments as follows :

(1) Chlorparacide at 1 oz. in $1\frac{1}{2}$ gallons i.e. 0·25%

(2) Chlorparacide at 1 oz.+Whiz.

(3) Chlorparacide at 2 ozs. in $1\frac{1}{2}$ gallons i.e. 0·50%

(4) Control

In all trials there appeared to be little if any deposit of Chlorparacide on the leaf.

In the last trials representative leaf samples were taken and the number of eggs counted at the time of Spraying and again after the incubation period. No active stages were noted on the second count from any sample including control. No conclusion can therefore be drawn from this.

From visiual inspections of the treated areas Chlorparacide alone seemed to have little effect in controlling Red Spider. Infestation in all cases appeared to be least in the plots receiving Lime Sulphur or Whiz treatment.

Selective Weed Killers.—A sample of Crag Herbicide was received from Messrs National Carbon Co. Ltd., for trial in weed control in thatch baris. This preparation is clamed to act as a germination inhibiting agent and must therefore be used before weeds have made much growth. It was however received too late for trials last spring, but it is hoped that it will be possible to try it out next season.

Swingfog Pest Control Unit.—A Swingfog Pest Control Unit was made available for trials in this district. This unit ejects a dense fog or smoke, of fungicide or insecticide. The particular unit used was designed for use with oil based chemicals only. It is believed that later models have been adapted to work with water based chemicals as well.

The original intention was that the unit should be used in trials against Blister Blight (*Exobasidium vexans*), but as an oil based fungicide was not available this was not possible. Instead light diesel oil was used and the trials were conducted to study the behaviour of the smoke and to try to assess the suitability or otherwise of the machine for use in a hill district.

Trials were carried out on four different dates and on all occasions the unit gave a lot of trouble from the mechanical point of view, which in spite of through servicing could not be rectified.

The earlier trials were conducted in typical monsoon conditions while the last was conducted in clear weather with a slight breeze blowing.

The force of ejection of the smoke is not great and it is dependent on drift by wind or air currents to carry it over the area to be treated.

Hill convexion currents being as they are, variable and unpredictable, make it almost impossible to use the unit satisfactorily as most of the smoke is caught on these currents and lost up the hill side. These conditions pertained during the first three trials. In the last trial when a slight breeze was blowing across the face of the hill results were somewhat more satisfactory.

It was found that by placing the unit on the road and projecting the smoke at the tea from a distance of about 3 feet that penetration to a depth of 3—4 bushes along a front, of about 4 rows could be obtained. Thereafter the smoke rose through the bushes and was caught in the breeze and carried over the surface of the bushes for some distance before rising up the hill side.

In all trials little or no deposit of oil could be found on the bushes. For this reason it is thought that the machine will not be of much use in the control of pests and diseases in tea. The efficiency of this machine probably lies in the fumigatory effect of the smoke, and is thus probably of much more use for such work as the fumigation of godowns or quarters.

In a district such as Darjeeling where much of the tea is planted on steep slopes and often on high terraces it is considered that the machine is too heavy and cumbersume for easy manipulation. The fog mixing tube gets extremely hot and if operators inadvertently touch this bad burns would result. In climbing up and down hill sides with the machine it is very probable that this would not be an uncommon occurrence.

A more detailed report on this machine and trials carried out with it appears elsewhere.

Blister Blight Control Trials—In Septmember a small trial against Blister Blight was laid out using the following treatments:

(1) Crag Fungicide 658 at 0·26%

(2) Bordofix 50 ,, 0·25%

(3) Shell Copper Fungicide at 0·85%

(4) Control.

To each fungicide a spreading agent "Sandovit" was added at the rate of 3·55 ozs. per gallon.

Each treatment was replicated four times.

Treatments were applied using pneumatic knapsack sprayers with low volume nozzles.

Fifty young leaves were taken at random from each plot at the time of spraying and a count of the number of blisters made A similar count was made after an interval of 10 days.

The results of the counts were as follows :—

Treatment No.	Plot No.	No. of blisters at the time of Spraying	No. of blisters 10 days after Spraying	Diff.	Total Diff.
1	1	53	32	−21	
	8	64	37	−27	−67
	10	46	50	+ 4	
	15	63	40	−23	
2	4	75	31	−44	
	7	67	40	−27	−49
	9	69	54	−15	
	14	47	84	+37	
3	2	78	20	−58	
	5	66	42	−24	−131
	11	77	46	−31	
	16	59	41	−18	
4	3	66	30	−36	
	6	65	52	−13	−97
	12	69	48	−21	
	13	73	46	−27	

From this it can be seen that there was a marked decrease in the number of blisters in all treatments including control. This was doubtless due to a large extent to the weather. At the time of spraying the disease had been severe, but in the week following spraying weather conditions improved greatly, and the disease lifted to a great extent throughout the area surrounding the trials plots as well.

It is hoped to conduct a similar trial next year earlier in the monsoon, when weather conditions are likely to be more constant.

Green Crops.—From the following green crops sown in March April 1953 seed was collected and resown :—

1. Crotalaria anagyroides.
2. Crotalaria grahamii.
3. Priotropis cytisoides.

These were sown at an elevation of about 5,500' and all have grown well.

After seed collection, the original plants were subjected to pollarding treatment. Every second plant was pollarded to about 1 foot. The alternate plants were only hedged and lopped.

All pollarded plants have made quite good regrowth, but it does not compare with the growth made by the plants sown in April this year ; this is doubtless due to the over-shadowing effect of the standards.

In all cases the lower stems of the standards have become very woody. However, from a visual inspection *Priotropis* appears to carry the greatest amount of succulent and leafy branches. C. grahamii appears to be second in order of merit in this respect, while C.anagyroides has grown tall and "spindly" with a very thin top hamper of leafy growth. At a later date succulent loppings from the three species will be weighed for comparison.

The natural leaf litter also appears to be greatest from *Priotropis*. It is intended next season to collect leaf droppings in baskets for comparative weighing.

Desmodium gyroides.—Planted in 1953 had not made sufficient growth to be lopped at the same time as the other species. At the present time it is still a very small plant and would hardly come above the level of the top of the tea bush.

Manuring and Pruning Experiments.—(a) The three manuring experiments and two of the pruning experiments referred to in the 1953 report are still ih progress, but at time of writing it is too early to have data to hand.

(b) The times of pruning experiment at Puttabong continues. In this experiment there are 12 treatments replicated four times. The four plots in the first treatment were pruned on 15th November, 1953, and those of the second treatment on 15th December, 1953 and so-on, on the 15th of each month. The blocks of the twelfth and last treatment were pruned on 15th October, this year.

Initial yields were taken in 1953 and experimental yields are now in the process of being recorded.

(c) A comprehensive co-operative N. P. K. experiment was laid out at Rungneet T. E. Initial yields have been taken throughout this year. Manures will be applied early in 1955.

R. P. W.—2000—5-55

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